U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-296 452

Sludge Exportation Study

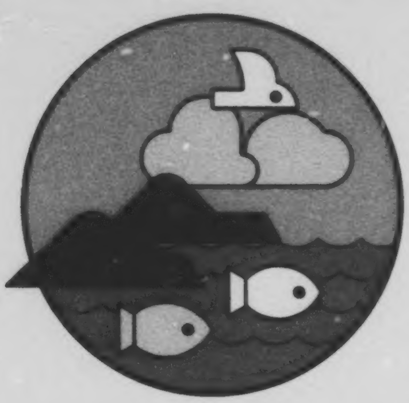
Los Angeles-Orange County Metropolitan Area Project, Whittier, CA

Prepared for

Environmental Protection Agency, San Francisco, CA

Aug 78

PB 296452



LA/OMA PROJECT

SLUDGE EXPORTATION STUDY

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

August 1978

BIBLIOGRAPHIC INFORMATION

PB-296 452

Sludge Exportation Study,

Aug 78

Clement Mesavage, Jr., and Mingin P. Lo.

PERFORMER: Los Angeles-Orange County Metropolitan Area
Project, Whittier, CA.
Grant EPA-C-06-1042-010

SPONSOR: Environmental Protection Agency, San Francisco,
CA. Region IX.

Report on LA/OMA Project. Sponsored in part by California State Water Resources Control Board, Sacramento., and Los Angeles County Sanitation District, CA.

The LA/OMA Project is to develop a long-term plan, including an implementation strategy to re-use or dispose of residual solids resulting from industrial and municipal wastewater treatment in the Los Angeles-Orange County metropolitan area. This report presents a reconnaissance level study that was made of the technical and institutional aspects of the maritime industry as that would bear upon the implementation of a sludge exportation system. Use of sludge in foreign countries is not included in the report as it was felt that any technological and institutional problems associated with the maritime industry would need to be first resolved.

KEYWORDS: *Sewage sludge, *Cargo transportation, *Solid waste disposal.

Available from the National Technical Information Service,
Springfield, Va. 22161

PRICE CODE: PC A06/MF A01

FOREWORD

Like other large urban communities, the Los Angeles-Orange County metropolitan area is currently experiencing a problem of sludge management. Currently, about 900 dry tons of undigested sludge is generated daily at the plants of the three major wastewater treatment agencies serving this area: the City of Los Angeles, Los Angeles County Sanitation Districts and Orange County Sanitation Districts. This amount may double by the year 2000 due to the population growth, requirements for improved levels of wastewater treatment, and federal and state regulations preclude ocean discharge of sludge. Simply stated the problem is that greatly increased amounts of wastewater solids will have to be managed efficiently and economically in an environmentally responsible and socially acceptable manner.

To avoid duplication of local efforts and to examine potential regional sludge management systems, the three local treatment agencies have joined with Region IX of the United States Environmental Protection Agency and the California State Water Resources Control Board to develop a Regional Wastewater Solids Management Program for the Los Angeles-Orange County Metropolitan Area (LA/OMA Project, for short). The LA/OMA Project is to develop a long-term plan, including an implementation strategy to reuse or dispose of residual solids resulting from industrial and municipal wastewater treatment in the Los Angeles-Orange County metropolitan area. The plan is to be complete by 1979 and is intended to lead immediately to the design and construction of facilities to serve the near future needs of the region from 1980-2000, with provisions to accommodate needs through the year 2020.

Exportation of sludge to other nations was included in the LA/OMA Project Phase I Report as a candidate system for evaluation. Mr. Clement Mesavage Jr., Environmental Systems Consultant, was retained to make a reconnaissance level study of the technical and institutional aspects of the maritime industry as that would bear upon the implementation of a sludge exportation system. This report presents the results of that study. Use of sludge in foreign countries is not included in the scope of this report since it was felt that any technological and institutional problems associated with the maritime industry would need to be first resolved.

This Project has been financed in part with Federal funds from the Environmental Protection Agency under grant number C-06-1042-011. The contents do not necessarily reflect the views and policies of the Environmental Protection Agency nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

LA/OMA Project
Regional Wastewater Solids Management Program
Los Angeles-Orange County Metropolitan Area
P.O. Box 4998/1955 Workman Mill Road
Whittier, California 90607
(213) 699-7411 From Los Angeles (213) 685-5217

REGIONAL WASTEWATER SOLIDS MANAGEMENT PROGRAM

LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

LA/OMA PROJECT

Bill Davis, Project Manager

This report was prepared by:

Clement Mesavage Jr.	Environmental Systems Consultant
Mingin P. Lo, D.Env.	Project Engineer LA/OMA Project

Under the Technical Direction of:

Roger T. Haug, Ph.D.	Senior Engineer LA/OMA Project

****

For information regarding this report write:
LA/OMA Project, P. O. Box 4998, Whittier,
California, 90607 or call (213) 699-7411

LA/OMA PROJECT

SLUDGE EXPORTATION STUDY

FOREWORD i

CHAPTER 1 INTRODUCTION AND STUDY APPROACH

INTRODUCTION AND STUDY APPROACH. 1-1
GLOSSARY 1-3

CHAPTER 2 SUMMARY OF FINDINGS

SUMMARY OF FINDINGS. 2-1

CHAPTER 3 LA/OMA PROJECT AREA PETROLEUM DOCKS

PETROLEUM DOCK LOCATIONS 3-1
DOCK ELEMENTS AND ADMINISTRATION 3-1
TANKER OPERATION AND OWNERSHIP 3-2

CHAPTER 4 LA/OMA PROJECT AREA TANKER ACTIVITY

TANKER ARRIVALS AND DEPARTURES 4-1
TANKER DESTINATIONS. 4-3

CHAPTER 5 TANKER SIZES AND CAPACITIES

SLUDGE GENERATION AND TANKER CAPACITY. 5-1
BACKHAUL FLEET SIZES AND CAPACITIES. 5-3

CHAPTER 6 TECHNOLOGICAL AND INSTITUTIONAL CONSIDERATIONS GOVERNING THE BACKHAUL ALTERNATIVE

TECHNICAL CONSIDERATIONS 6-1
    North Slope Crude and Tanker Availability . . . 6-1
    Tanker Pumps. 6-2
    Cargo Tank Cleaning 6-3
    Use of Segregated Ballast Tanks 6-5
    Tank Corrosion. 6-8
    Sludge Handling and Tanker Safety 6-9
    Tanker Air Pollution. 6-12
    Dock Water Depth Constraint 6-12

INSTITUTIONAL CONSIDERATIONS 6-13
    United States Coast Guard 6-13
    Southern California Association of Governments. 6-14
    California Coastal Zone Conservation Comm . . . 6-14
    Air Pollution Control Agencies. 6-15
    The Federal Department of Commerce. 6-16
    The World Health Organization 6-16
    The Petroleum Industry. 6-16

INTERIM CONCLUSIONS. 6-17

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-296 452

Sludge Exportation Study

Los Angeles-Orange County Metropolitan Area Project, Whittier,

Prepared for

Environmental Protection Agency, San Francisco, CA Region IX
Fld 5 - CA

Aug 78

CHAPTER 7 BACKHAUL ALTERNATIVE IMPLEMENTATION

DOCK AVAILABILITY. 7-1
  Implemented Backhaul Dock & Storage Locations. 7-2

TANKER LOADING OF SLUDGE 7-2
APPLIED SAFETY 7-3

CHAPTER 8 TANKER CHARTERING, ECONOMICS, AND INSURANCE

TANKER CHARTERING AND SLUDGE HANDLING. 8-1
TANKER OPERATION ECONOMICS 8-3
  Petroleum Industry Operation & Maintenance Costs 8-3
  Agency Backhaul Rate Negotiation Leverage. . . 8-5

MARINE INSURANCE 8-6

CHAPTER 9 CAPITAL COST OF CO-USE AND SEPARATE FACILITIES

CAPITAL COST OF CO-USE AND SEPARATE FACILITIES . . 9-1
POTENTIAL REDUCTIONS IN CAPITAL COSTS. 9-3

CHAPTER 10 INTEGRATED BACKHAUL SYSTEM COSTS

INTEGRATED BACKHAUL SYSTEM COSTS 10-1
TANKER OPERATION COSTS TO OTHER NATIONS. 10-2

CHAPTER 11 AIR POLLUTION IMPACT/ENERGY DEMAND

AIR POLLUTION IMPACT/ENERGY DEMAND 11-1

CHAPTER 12 BACKHAUL ALTERNATIVES AND THE FUTURE

FUTURE SEGREGATED BALLAST CAPACITY 12-1
OCEAN DISPOSAL 12-1
CARGO TANK OIL WASHING AND SLUDGE HANDLING 12-2
BARGES 12-2

CHAPTER 13 CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS. 13-1
RECOMMENDATIONS. 13-1

APPENDIX A ACKNOWLEDGEMENTS

APPENDIX B REFERENCES

APPENDIX C U.S. COAST GUARD FORM 4355 "CHARACTERISTICS OF LIQUID CHEMICALS PROPOSED FOR BULK WATER MOVEMENT"

APPENDIX D TYPICAL MARITIME INDUSTRY TIME AND VOYAGE CHARTER FORMS

LIST OF FIGURES

FIGURE PAGE

3-1 LA/OMA PROJECT MARINE PETROLEUM DOCKS 3-3

3-2 TYPICAL DOCK ELEMENTS 3-4

4-1 LA/OMA PROJECT SLUDGE EXPORTATION STUDY NATIONS 4-7

5-1 DEPARTING TANKER FLEET SIZES/CAPACITIES 5-5

5-2 FLEET 1 + 2 DEPARTURE FREQUENCY TO REGION 1 5-7

6-1 TANK CLEANING MACHINE OPERATING IN CARGO COMPARTMENTS . 6-6

6-2 FLAMMABILITY DIAGRAM FOR OXYGEN/HYDROCARBON GAS MIXTURE 6-10

8-1 TANKER ACCIDENT RATE PER LOCATION 8-7

9-1 CAPITAL COST PERMUTATIONS 9-2

LIST OF TABLES

Table | Page
2-1 SUMMARY OF TANKER ACTIVITIES TO FOREIGN PORTS, LA/OMA REGION, 1976 2-3
2-2 TOTAL COSTS FOR SLUDGE EXPORTATION, LA/OMA AGENCIES YEAR 2000 2-4
4-1 TANKER ARRIVALS/DEPARTURES TO LA/OMA PROJECT AREA PETROLEUM DOCKS - 1976 4-2
4-2 FOREIGN NATIONS/TANKER ACTIVITY - 1976 - LA/OMA PROJECT AREA PETROLEUM BERTHS. 4-4
4-3 TANKER ARRIVALS/DEPARTURES - 1976 TOTALS 4-8
5-1 SLUDGE QUANTITIES FROM LA/OMA PROJECT AREA PLANTS. . . . 5-2
6-1 WATER DEPTHS AT LA/OMA PROJECT AREA DOCKS. 6-13
8-1 COSTS OF TANKER OPERATION TO LOS ANGELES-PETROLEUM CARGOS 8-4
8-2 AGENCY BACKHAUL RATE NEGOTIATION LEVERAGE TO INDONESIA - SLUDGE CARGO 8-6
9-1 SUB-REGIONAL CAPITAL COSTS - BACKHAUL PERMUTATION #1 . . 9-1
10-1 ESTIMATED INDONESIAN BACKHAUL ALTERNATIVE COSTS - AGENCY LEASED DOCKS. 10-1
11-1 BACKHAUL ALTERNATIVE OPERATIONAL AIR POLLUTION. 11-1
11-2 AIR EMISSION FACTORS 11-1
11-3 TOTAL BACKHAUL OPERATION ENERGY USE. 11-2

CHAPTER 1

INTRODUCTION AND STUDY APPROACH

The Los Angeles/Orange County Metropolitan Area Project (LA/OMA Project) is a regional wastewater solids management undertaking which has involved a systematic evaluation of eighteen sludge reuse and/or disposal alternatives, referred to as "candidate systems". The LA/OMA Project is charged to develop by 1979 a long-term sludge management plan, including an implementation strategy, for the wastewater solids from the combined sewer service area of the Joint Outfall Districts of the Los Angeles County Sanitation Districts, the service area of the City of Los Angeles, and the service area of the Orange County Sanitation Districts.

The purpose of this feasibility study is to make a reconnaissance-level evaluation of the technical and institutional aspects that would be associated with the implementation of LA/OMA Project Candidate System Number 16, "Exportation". The feasibility study excludes the sludge marketing element of the exportation alternative, i.e. it does not disclose which foreign countries would be receptors of the sludge.

Candidate System 16 was originally described by the staff of the LA/OMA Project as follows (1):

> Candidate System 16 (Exportation) would require waste activated sludge to "be thickened and blended with raw primary sludge. The combination would then be anaerobically digested and transported via pipeline to oil tanker loading facilities. Tankers would take on liquid sludge as ballast, following discharge of their crude oil, for the return trip to the oil exporting nations. This return trip is termed as "empty haul" since no useful product is transported. The advantage of Candidate System 16 is that no additional energy would be required to transport liquid sludge in place of normal sea water ballast and no liquid sidestreams would have to be treated. Conditions prevalent in developing nations seem to indicate a potential market for soil conditioning materials such as digested sludge. However, market viability and transportation costs need to be examined".

CH2M-Hill, Inc., has expounded on this system description in an initial analysis (2) of the socio-economic and the technical and environmental ramifications of the exportation alternative. One system permutation suggested involved the contractural dedication of tankers exclusively for sludge transport. The original idea of taking advantage of a returning tanker's empty haul would be abandoned. This transformation in the exportation alternative was considered a possibility if it was determined that petroleum carriers would be reluctant to handle sludge because of one or more of a variety of reaons, e.g. normal dock operations and scheduling would not be compatible with vessel demurrage time that might result from the handling of the sludge at their docks. Although the impetus of this feasibility study as conceived in the contracted scope of work was geared toward the identification of the technical and institutional constraints associated with the implementation of the original idea, i.e., taking advantage of the empty haul (the idea herein referred as the "backhaul" alternative), the suggestion by CH2M-Hill of using dedicated tankers has been reviewed in this reconnaissance-level report.

It should be noted, however, that there is basically only an economic differential between a backhaul versus a dedicated-tanker scheme with the technical and institutional constraints of both schemes being essentially identical.

One important refinement in the original description of Candidate System Number 16 is also reflected in this study. It had been envisioned that the sludge would be utilized as ballast only on a tanker's return voyage, however, this study reflects the fact that a tanker could return entirely loaded with sludge placed in all of the cargo tanks. Furthermore, the report introduces the fact that many tankers have physically segregated ballast tanks (called "clean water ballast" tanks) which are only loaded with seawater as opposed to some cargo tanks on a tanker "administratively" dedicated to clean water ballast. Thus, since the sludge might be loaded in these tanks rather than the cargo tanks, the term ballast has been more clearly defined in this study in terms of the type of tanks any one particular tanker builder or operator has dedicated to clean water ballast.

Finally, and most importantly, the study was not completed under the assumption that the implemented exportation alternative would necessarily have to be acknowledged as an independent system, flexible enough to include the means of handling all of one LA/OMA Project area sludge. Rather, this study's approach reflects the fact that the LA/OMA Project area wastewater treatment plants are in close proximity to the region's petroleum docks, and that whereas the dock(s) of one area might be able to cater to the wastewater plant of their vicinity, the dock(s) within another wastewater treatment plant vicinity might not be able to handle sludge. Thus, the majority of the data collected for the study was compiled on a sub-regional, wastewater plant/tanker dock basis such that alternative permutations might be envisioned and considered as potential candidate sub-systems that could be incorporated as complimentary elements of the ultimate sludge management program chosen for the entire LA/OMA Project area region.

GLOSSARY

The following are definitions of terms used in this report.

Ballasting - Action necessary after the cargo has been discharged to immerse hull, propeller, and rudder in the interest of controllability on the ship.

Barrel - One barrel = 42 American gallons = 34.9726 Imperial gallons.

Bulk - The mass of some cargo not packaged.

Demurrage - The detention of a vessel by the charterer beyond the time allowed for loading, unloading, etc.; also, the payment made for such detention.

Discharge - Tanker unloading.

Dock - Formally called a marine terminal, a dock may comprise one or more vessel berths either adjacent to shore, or offshore.

Deadweight Tons (DWTs) - A deadweight ton equals 2240 pounds. On a tanker, the number of DWTs represents the total weight of the cargo and ballast plus the ship fuel oil, crew provisions, and the crew itself. The conversion from DWTs to barrels of capacity is dependent on the density of each ship liquid, e.g. crude oil at an average of around 7 barrels/long ton. The deadweight tonnage may be considered to be the weight that displaces a certain volume of sea water.

Inerting - In this process, a tank is made to draw in inert gas instead of fresh air as the cargo is discharged, thereby lowering the oxygen content of the tank atmosphere and making it safe from explosion or fire.

Long ton - Equals 2240 pounds.

Operator - The parties physically operating and managing a ship's voyage.

CHAPTER 2

SUMMARY OF FINDINGS

The feasibility of LA/OMA Project Candidate System #16, Sludge Exportation, was explored in terms of sewage sludge/ocean-going tanker capability. Tankers returning to exportating nations upon departing from LA/OMA Project area docks in 1976 were investigated as potential sludge backhaul candidates.

The ballast voyages of the tankers were found to have been made primarily to the Indonesian (56%), the Persian Gulf (19%), and the South American (12%) world regions, and the individual backhaul "fleets" were characterized based on tanker sizes, frequency, and cargo and segregated ballast capacities. Details of the tanker activities to foreign ports are given in Table 2-1.

LA/OMA Project area docks that received tankers from foreign nations were documented. Tanker frequencies at any single dock of the POLA/POLB Harbor Complex were found to be small, i.e. the number of arrivals or departures operating between any one nation was small when investigated in terms of necessary tanker frequency to transport in cargo tanks the 8.8 MGD of sludge anticipated to be generated within the LA/OMA Project area in 2000.

Likewise, tanker frequency was found to be the limiting factor at the offshore Gulf Oil Huntington Beach dock, however the total cargo capacity of all tankers operating between the Indonesian region and the offshore El Segundo docks was documented to have been approximately sufficient to transport the 8.8 MGD of sludge.

A review of the technical considerations, however, revealed that tanker availability would be subject to various constraints. First, the Alaskan crude oil may replace a significant volume of oil imported in tankers to the West Coast. Secondly, some tankers that arrived in 1976 had cargo lubricating pumps that may require external lube-line retrofitting for sludge transport. Third, cargo tank cleaning and inerting may be necessary if sludge cannot be mixed with residue crude and if explosive hazards exist during sludge handling, respectively.

Moreover, sludge transport may promote corrosion in the tankers that arrive without protective-coated tanks, and sludge loading would necessitate the installation of vapor recovery systems to collect the hydrocarbon vapor displaced.

With regard specifically to segregated ballast tankers, capacity was determined to currently be a limiting factor for the exportation of all sludge to any one of the above world regions. Further, many tankers do not have adequate venting on the segregated tanks, and/or they may not have discharge pipelines for sludge transfer to the tanker decks.

Institutional considerations may also effect tanker availability. In addition to the various governmental agency concerns, the LA/OMA Project Area Sanitation Agencies would be forced to compete with the oil industry for tankers that may be owned and/or operated by a multitude of concerns in a world market, and chartering would most likely have to be done on a per-tanker basis. That would in effect greatly limit the control Agencies would have over a successful backhaul operation.

Therefore, departing tanker capacity available for sludge backhauls may be drastically limited, however if it is assumed that 56% or approximately 99 of the LA/OMA Project Area total of 177 tankers documented to have returned to the Indonesion region were available for a full capacity sludge load, the 2000 volume of sludge could be exported.

Such a backhaul operation would most likely mandate the co-lease of at least four sub-regional docks, and the operations could necessitate the construction of a minimum of three "sludge docks" if tank cleaning was deemed necessary.

The estimated exportation costs of either an Agency-leased or an Agency-operated backhaul alternative to the Indoesian region would be approximately $56/dry ton of raw sludge, assuming a negotiated tanker freight rate of $20/dry ton ($1/wet ton of digested sludge), an amortized capital cost for dock loading & storage facilities of $18/dry ton and an annual operating cost of $18/dry ton. The total cost including the treatment plant sludge processing costs, would amount to $82. to $89/dry ton. Details of the cost break down are given in Table 2-2. Capital and O & M costs for thickening, digestion and the combined cycle powerplant were provided by the LA/OMA Project.

The capital cost for the exportation facilities includes the loading and storage facilities at the docks. Based on the average time lapsed between ship departures in 1976, a storage capacity for 12 days of sludge was assumed. The operating costs include tanker wharfage, dockage and demurrage fees together with expenses of the Agency facilities at the docks. It is conceivable that adjustments in the storage costs and the negotiated freight rate may be possible.

It is concluded that sludge exportation is not a viable alternative for the management of all sludge of the LA/OMA Region Sanitation Agencies. This conclusion is based primarily on the fact that costs associated with tanker transport of sludge to the prevailing exporting nations could be expected to be exceedingly high. Further, the large volume of sludge would mandate the use of crude oil cargo tankage that would most likely necessitate time-intensive tank cleaning. It should be noted, however, that a limited opportunity involving individual Agencies may arise if one or more independent tanker operators wished to transport the sludge overseas.

It is also concluded that it may be possible for tankers to be used as vehicles for sludge transport and dispersal in the open ocean. Specifically, the segregated ballast capacity of the tankers departing Standard Oil of California at El Segundo might be used for the transport and dispersal of a part of the sludge of the adjacent Hyperion Sewage Treatment Plant.

TABLE 2-1

SUMMARY OF TANKER ACTIVITIES TO FOREIGN PORTS

LA/OMA REGION, 1976

Destination	Tanker Departure		TANKER CAPACITY			
			Cargo		Segregated Ballast	
	No.	% Total	10^6Ton/Yr.	MGD	10^6Ton/Yr.	MGD
INDONESIAN REGION						
LA/LB	83	-	9	5.8	1.0	0.6
EL SEGUNDO	94	-	14	9.4	1.6	1.1
TOTAL	177	56	23	15.2	2.6	1.7
PERSIAN GULF	61	19	6.8	4.5	0.8	0.54
SOUTH AMERICA	38	12	2.4	1.6	0.2	0.12
OTHERS	38	12	-	-	-	-

TABLE 2

TOTAL COSTS FOR SLUDGE EXPORTATION - LA/OMA AGENCIES, YEAR 2000

PROCESS	City of Los Angeles (HTP)			LACSD (JWPCP)			OCSD		
	CAP.	O & M	TOTAL	CAP.	O & M	TOTAL	CAP.	O & M	TOTAL
				($ Million/Year)					
In Plant Processing									
DAF THICKEN. 1/	1.8	1.3	3.1	1.2	1.0	2.2	1.3	1.0	2.3
ANAEROBIC DIGESTION 1/	1.2	1.2	2.4	2.4	1.5	3.9	1.5	1.0	2.4
POWER PLANT 1/	0.4	0.1	0.5	0.6	0.1	0.7	0.3	0.1	0.4
Sub-total	3.4	2.6	6.0	3.2	2.6	6.8	3.1	2.1	5.1
EXPORTATION SYSTEM									
PIPELINE & PUMP TO DOCK	0.3			0.45			0.3		
STORAGE TANKS 2/	3.0			3.3			1.4		
DOCK ACCESSORIES	0.7			0.85			0.7		
Sub-total 3/	4.0	1.4	5.4	4.6	1.8	6.4	2.4	1.1	3.5
TANKER OPERATION									
FREIGHT 4/	-	3.9	3.9	-	5.1	5.1	-	3.2	3.2
DOCK CHARGES	-	2.2	2.2	-	2.8	2.8	-	1.8	1.8
Sub-total	-	6.1	6.1		7.9	7.9	-	5.0	5.0
TOTAL	7.4	10.1	17.5	8.7	12.4	21.1	5.5	8.2	13.6
UNIT COST									
Dry ton/Day		540			705			440	
$/Dry Ton Raw Sludge		88.8			82.0			84.7	

NOTES:

1/ LA/OMA Project, "Preliminary Computer Analysis of Sludge Management Alternatives", April 1978.

2/ 12 Day Sludge Storage Assumed - maximum tanker time gap for 1976 was 6 days.

3/ An expensive vapor recovery system @ $0.64 million/year was assumed for each dock.

4/ A freight cost of $1/wet ton of digested sludge or $20/dry ton of raw sludge was assumed.

Capital costs adjustment, ENR= 3031.

CHAPTER 3

LA/OMA PROJECT AREA PETROLEUM DOCKS

PETROLEUM DOCK LOCATIONS

There are several petroleum terminals ("docks") that directly serve the Los Angeles/Orange County Metropolitan Area. All but two of these docks comprise wharfside berths within the Ports of Los Angeles (POLA) and Long Beach (POLB). The two remaining docks comprise: 1) four offshore "berths" serving Standard Oil of California located one and one-third miles off the coastline adjacent to El Segundo of Los Angeles County, and 2) one offshore "berth" serving Gulf Oil Corporation, and to a lesser extent Southern California Edison Company, located one and three-eights miles off the coastline adjacent to Huntington Beach of Orange County.

Figure 3-1, distinguishes the petroleum berths of each terminal operator within the POLA/POLB Harbor Complex (Harbor Complex), and it gives the location of the offshore berths of both Standard Oil and Gulf Oil. It can be seen that these docks are in close proximity to the largest LA/OMA Project area sewage (wastewater) treatment plants which collect the sewered wastewater of Los Angeles and Orange Counties. The petroleum berths offshore of El Segundo (118° 26'W, 33° 54'N) are approximately one and three-quarters miles southwest of the City of Los Angeles Hyperion Sewage Treatment Plant (Hyperion). The berths of the POLA and the POLB are approximately three and four miles southwest, respectively, from the Los Angeles County Sanitation Districts' Joint Works Water Pollution Control Plant (JWPCP) in Harbor City. Finally, Gulf Oil's offshore berth (33° 38'N, 118° 0'W) is approximately two and one-third miles east of the County Sanitation Districts' of Orange County Plant #2 (CSDOC Plant #2) in Huntington Beach. Together, these plants handled approximately 21,000 wet tons of raw sewage sludge daily in 1976; approximately 200 wet tons a day of additional sludge was also handled by the small City of Los Angeles Terminal Island Treatment Plant of Terminal Island, California, within the Harbor Complex, and within one mile of the nearest petroleum dock (3).

DOCK ELEMENTS AND ADMINISTRATION

Figure 3-2 shows typical wharfside and offshore LA/OMA Project Area dock arrangements including dock elements. Each of the docks is served by bulk ocean-going vessels known as tankers, a small number of which are referred to as bulk/ore or bulk/oil tankers (bulk/ore tankers typically carry both ore slurry and petroleum separated by one bulkhead and bulk/oil tankers carry oil plus one or more of a variety of other bulk cargos, such as chemicals, in several independent compartments). The various petroleum dock concerns typically facilitate tankers carrying both crude oil and refined petroleum products (primarily imported crude oil), however some docks also handle a variety of chemicals such as gasoline additives.

After a tanker has docked, the vessel's discharge manifold is connected to the discharge unloading arms of the dock, or in the case of the offshore berths, to the pipeline end manifold (plem). Then the particular cargo is discharged (utilizing shipboard pumps) through a pipeline to onshore storage tanks that may be adjacent to the dock or that could be many miles inland of the dock. From the "tank farm", the cargo is either marketed or it is transferred to a processing plant, e.g. an oil refinery.

The crude oil, refined products, or chemicals imported to the LA/OMA Project area docks in 1976 were received almost exclusively by oil company concerns, however, the Department of Water and Power of the City of Los Angeles, and the United States Navy also had some imports (LA 181 received power plant fuel oil, and LA 39 received jet fuel, respectively). In addition, and as disclosed above, the Southern California Edison Company utilized the offshore Huntington Beach berth which is owned by Gulf Oil, however, Edison received no foreign shipments in 1976; it only received domestic fuel oil to power its Huntington Beach power plant (Edison has a contract with Gulf to use the berth any time, however, Gulf retains the right-of-first-use of the dock).

TANKER OPERATION AND OWNERSHIP

Various tanker operators (the parties physically operating and managing a ship's voyage) and agents (the parties that represent the operator in ports the operator is unfamiliar, e.g. transmitting vessel instructions) handled the vessels that arrived at LA/OMA Project area docks in 1976. The tankers may be owned by a particular oil company acting as the vessel's operator, e.g. Atlantic Richfield (ARCO) owned some of the ships that discharged at LB 118, such as the tanker ARCO Independence. The balance of the ships arrived at docks like LB 118 were owned by various interests or individuals that also typically operated their tankers. Unlike the tankers that operated in domestic trade, the majority of the tankers from foreign nations that arrived at the LA/OMA Project area docks in 1976 were not owned by the individual oil companies (4). Rather, the oil companies in liaison with New York City brokers, negotiated vessel charters with various tanker owner/operators that have their headquarters in a multitude of worldwide cities.

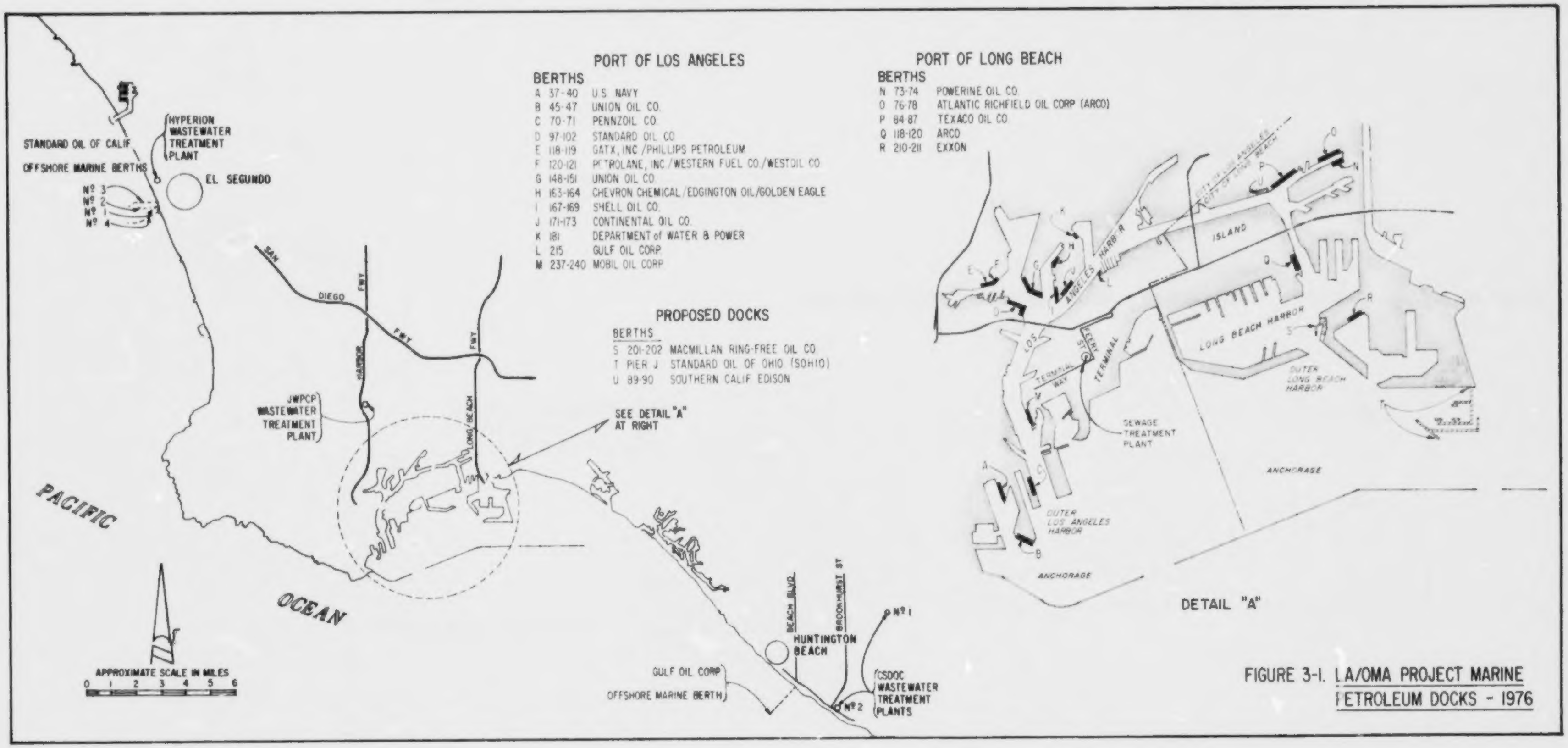
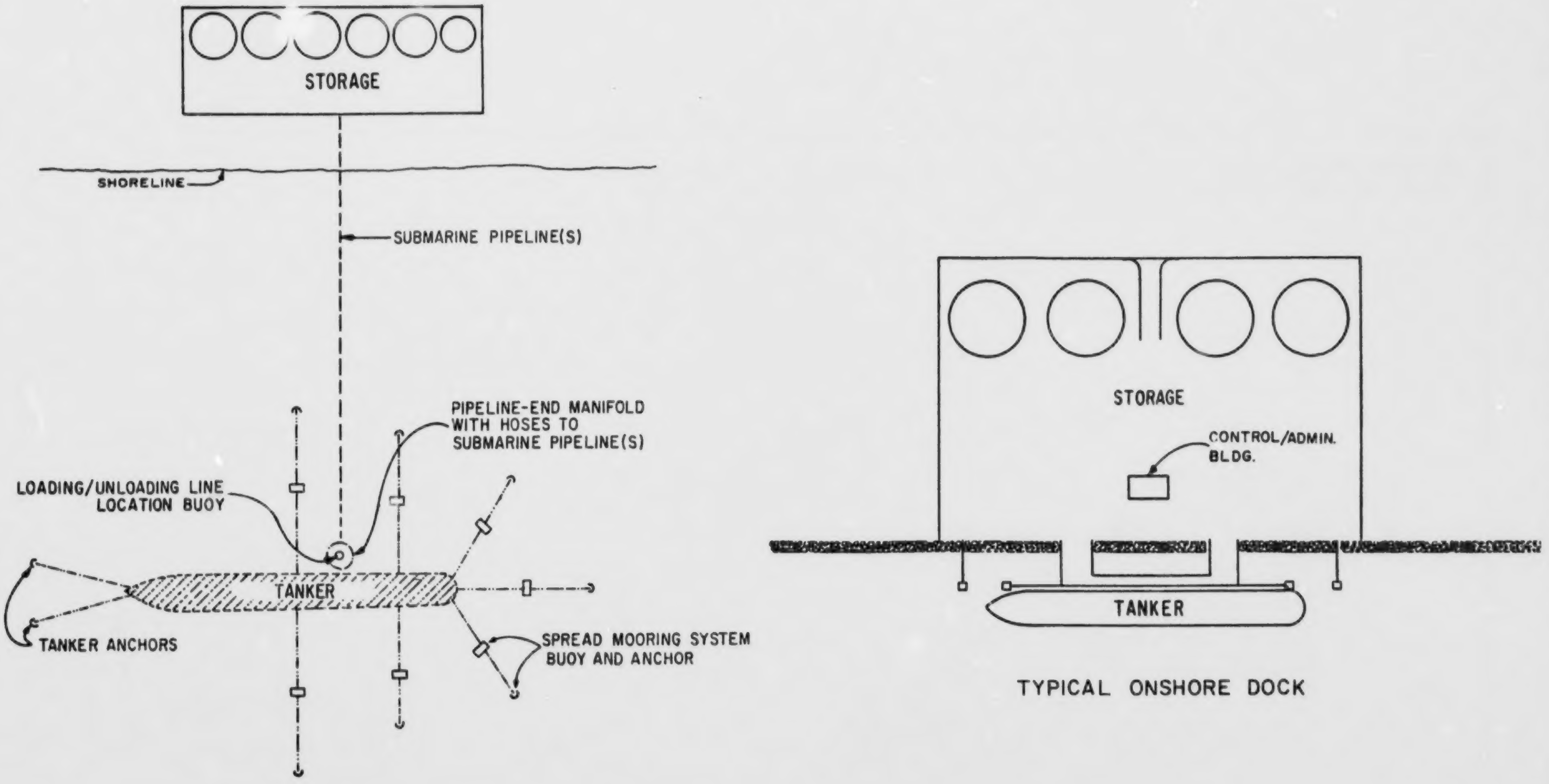


FIGURE 3-1. LA/OMA PROJECT MARINE PETROLEUM DOCKS - 1976


STORAGE
SHORELINE
SUBMARINE PIPELINE(S)
PIPELINE-END MANIFOLD WITH HOSES TO SUBMARINE PIPELINE(S)
LOADING/UNLOADING LINE LOCATION BUOY
TANKER
TANKER ANCHORS
SPREAD MOORING SYSTEM BUOY AND ANCHOR
STORAGE
CONTROL/ADMIN. BLDG.
TANKER

TYPICAL OFFSHORE DOCK

TYPICAL ONSHORE DOCK

FIGURE 3-2. TYPICAL DOCK ELEMENTS

CHAPTER 4

LA/OMA PROJECT AREA TANKER ACTIVITY

TANKER ARRIVALS AND DEPARTURES

Data on tanker activity for the POLA/POLB Harbor Complex area were extracted from the vessel log of Marine Exchange of Los Angeles-Long Beach Harbor, Inc. Similar data for the offshore berths of Standard Oil and Gulf Oil were obtained from the Marine Department logs of the two oil firms. Data were compiled for the year 1976, which was chosen as the reference year for the feasibility study.

In accord with the idea of sludge exportation, the tankers that departed from LA/OMA Project docks to foreign nations were documented in the appendices. In addition, tankers that arrived at LA/OMA Project area docks from foreign nations were also included to complement the vessel departure data. These vessels are typically called "foreign tankers" because they "sail" under foreign flags, i.e. the flag designates the nation in which the tanker is registered for commercial transport. However, a few tankers arriving from foreign nations sail under an American (domestic) flag (although it is much more expensive because the tanker operator must employ American sailors from domestic maritime unions). Therefore, in this feasibility study, the term "foreign tanker" was not used. Rather, the phrases "tankers from a foreign nation", and "tankers departing to a foreign nation" were utilized.

It should be noted that some tankers that arrived at the POLA/POLB Harbor Complex from a foreign nation did not discharge (unload) at a dock, e.g. they only came within the Harbor Complex breakwater to re-fuel ("bunker") while at anchor in the Outer Harbor. Therefore, these tankers were not documented in the data compilation. Furthermore, it should be understood that the total number of tankers documented for this feasibility study represents only a fraction of the total number of tankers that arrived at the docks of Figure 3-1 above, i.e. the domestic tankers (typically coastal tankers operating between the ports of the San Francisco Bay Area and Los Angeles handling domestic crude or refined products), and "lightering" tankers (tankers that were loaded with crude transferred from very large crude carriers (VLCC's) off San Clemente Island for domestic shipment), were not included in the data compilation. Thus for the Harbor Complex, of the 1261 tanker arrivals in 1976(5), only 231 tankers during the twelve months of 1976 discharged at one of the Harbor Complex docks. Likewise, for Standard Oil's berths offshore of El Segundo, of the 324 tankers that arrived in 1976(6), only 104 arrived from a foreign country. However for Gulf Oil's berth offshore of Huntington Beach, of the 23 vessel arrivals (7), 20 of the tankers were from foreign nations. Table 4-1 gives the number of tanker arrivals and departures to individual LA/OMA Project area petroleum docks in 1976.

TABLE 4-1 Tanker Arrivals/Departures To LA/OMA Project Area Petroleum Docks - 1976[1]

	Berths [3]	(Tankers/Year[2]) Arrivals	Departures
Port of Los Angeles			
Union Oil Co.	LA 45-47	47	33
Continental Oil Co.	LA 171-173	17	18
GATX, Inc./Phillips Petroleum	LA 118-119	13	20
Shell Oil Co.	LA 167-169	14	17
Chevron Chem/Edgington Oil/ Golden Eagle	LA 163-164	13	14
Union Oil Co.	LA 148-151	7	5
Pennzoil Co.	LA 70-71	7	4
L.A. Dept. Water & Power	LA 181	6	1
Petrolane, Westoil Co. Inc./ Western Fuel Co.	LA 120-121	5	5
Mobil Oil Corp.	LA 237-240	3	9
Gulf Oil Corp.	LA 215	2	4
U.S. Navy	LA 37-40	2	3
Standard Oil Co., Calif.	LA 97-102	1	4
POLA 1976 TOTALS:		137	137
Port of Long Beach			
Atlantic Richfield (ARCO)	LB 118-120	47	38
Texaco, Inc.	LB 84-87	27	13
Powerine	LB 73-74	11	6
ARCO	LB 76-78	9	6
Exxon, Inc.	LB 210-211	0	1
POLB 1976 TOTALS:		94	64
1976 POLA/POLB HARBOR COMPLEX TOTALS:		231	201
Standard Oil of Calif. El Segundo, Offshore	Berth #4	104	99
Gulf Oil Corporation Huntington Beach, Offshore	Single Berth	20	14
1976 LA/OMA PROJECT AREA TOTALS:		355[4]	314

1/ Frequencies derived from the compilation of data on tanker activity.

Includes:
1) Tankers arriving from foreign nations.
2) Tankers departing directly for foreign nations.
3) Seven tankers that departed for foreign nations via a domestic port, e.g. San Francisco.

Excludes:
1) Domestic coastal tankers operating between domestic ports.
2) Lightering tankers operating to and from San Clemente Island.
3) Tanker terminals LA 187 and LB 32-33.

2/ Totals represent the actual number of tankers, e.g. a tanker that arrived at offshore Huntington Beach might depart for LA 171-173 to discharge his remaining cargo, and then depart for a foreign nation. For this example, only one tanker departure would have been recorded (LA 171-173 to the foreign nation).

3/ Based on port lease or wharfside land ownership; a terminal (dock) is comprised of one or more berths.

4/ The number of LA/OMA Project area tanker arrivals exceeds the number of tanker departures because, a) The end-of-the-year, 1977 departures were not recorded, and b) some tankers from foreign nations departed the POLA/POLB for domestic ports, i.e. they were recorded by Marine Exchange of Los Angeles-Long Beach Harbor, Inc., to have departed only for a domestic port (the tanker's ultimate destination upon leaving the domestic port was unavailable). Such tankers may have gone to the domestic port, e.g. San Francisco, for repairs.

TANKER DESTINATIONS

In addition to vessel frequency data, the nations where the tankers loaded and the destinations of the tankers that departed the LA/OMA Project area petroleum docks were identified. Records were not obtainable to disclose the destination (next loading, repair, or bunkering stop) of all the tankers departing the El Segundo and Huntington Beach Offshore berths. However, based on the tanker arrival data, the Marine Department Receiving Directors of both Standard Oil and Gulf Oil have disclosed their confidence that the (unrecorded) vessels returned to the same country in which they had loaded the crude (8).

Table 4-2 distinguishes the foreign nations that tankers visited in 1976 in relation to the vessel arrival and departure frequencies compiled on a per dock basis. Figure 4-1 gives the world location of these foreign nations. Data of Table 4-2 reveal that the individual berths of the Harbor Complex and the offshore Gulf Oil berth, do not have high arrival and departure rates relative to the offshore berth of Standard Oil at El Segundo.

TABLE 4-2 FOREIGN NATIONS/TANKER ACTIVITY - 1976 - LA/OMA PROJECT AREA PETROLEUM BERTHS [1]

Berths	Tankers Arrived From (#):	Tankers Departed To (#):[2]
LA 45-47	Indonesia (30) Saudia Arabia (14) Iran (1) Malaysia (1) Mexico (1)	Indonesia (23) Saudia Arabia (6) Malaysia (2) Singapore (1) Japan (1)
LA 171-173	Saudia Arabia (7) Indonesia (6) Chile (2) Singapore (1) Venezuela (1)	Singapore (5) Ecuador (4) Saudia Arabia (4) Indonesia (3) Columbia (1) Japan (1)
LA 118-119	Indonesia (6) Saudia Arabia (2) Malaysia (1) Mexico (1) Ecuador (1) Venezuela (1) Japan (1)	Indonesia (7) Saudia Arabia (3) Singapore (3) Canal Zone (2) Mexico(1) Japan (1) China (1) Kuwait (1) Brazil (1)
LA 167-69	Saudia Arabia (6) Indonesia (3) Colombia (1) Nigeria (1) Venezuela (1) Chile (1) Iran (1)	Saudia Arabia (7) Indonesia (3) Venezuela (2) Singapore (2) Japan (2) Trinidad (1)
LA 163-64	Indonesia (8) Mexico (1) Philippines (1) Trinidad (1) Venezuela (1) Japan (1)	Indonesia (4) Japan (4) Canal Zone (2) Venezuela (2) Ecuador (1) Saudia Arabia (1)
LA 148-151	Mexico (7)	Mexico (5)
LA 70-71	Japan (5) France (1) S. Korea (1)	Japan (1) Netherlands (1) Venezuela (1) Colombia (1)
LA 181	Indonesia (3) Venezuela (2) Singapore (1)	Saudia Arabia (1)

Berths	Tankers Arrived From (#):	Tankers Departed To (#):[2]
LA 120-121	Trinidad (2) Mexico (1) Canal Zone (1) Algeria (1)	Japan (3) Mexico (1) Canal Zone (1)
LA 237-240	Indonesia (3)	Indonesia (4) Saudia Arabia (4) Singapore (1)
LA 215	Mexico (2)	Mexico (2) Singapore (1) Canal Zone (1)
LA 37-40	Japan (2)	Mexico (1) Japan (1) Panama (1)
LA 97-102	Saudia Arabia (1)	Indonesia (1) Singapore (1) Taiwan (1) Saudia Arabia (1)
LB 118-120	Indonesia (18) Iran (11) Nigeria (7) Ecuador (7) Saudia Arabia (2) Canal Zone (1) Tunisia (1)	Iran (15) Japan (8) Indonesia (5) Singapore (5) Ecuador (4) Peru (1)
LB 84-87	Indonesia (21) Saudia Arabia (4) Trinidad (2)	Indonesia (3) Trinidad (4) Singapore (3) Saudia Arabia (2) Equador (1)
LB 73-74	Indonesia (8) Saudia Arabia (1) Ecuador (1) Philippines (1)	Singapore (3) Indonesia (2) Ecuador (1)
LB 76-78	Indonesia (3) Ecuador (2) Nigeria (1) Japan (1) Venezuela (1) Kuwait (1)	Indonesia (1) Japan (1) Ecuador (1) Netherlands (1) Australia (1) Nicaragua (1)
LB 210-211	No tankers arrived from foreign countries	Canal Zone (1)
El Segundo Offshore Berth #4 [3]	Indonesia (97) Saudia Arabia (6) Malaysia (1)	Indonesia (94) Saudia Arabia (5)

Berths	Tankers Arrived From (#):	Tankers Departed To (#):2/
Huntington Beach Offshore Berth 4/	Saudia Arabia (17) Equador (3)	Saudia Arabia (11) Ecuador (3)

1/ Frequencies derived from the compilation of data on tanker activity.

2/ Seven tankers departed via a domestic port, e.g. San Francisco. Arrivals may exceed departures, i.e. some tankers from foreign nations were recorded to have departed only for a domestic port because the tanker's destination upon leaving the domestic port was unavailable.

3/ Five tankers that arrived to Offshore Berth #4, departed via a Harbor Complex berth. Therefore, tanker departures were recorded to have exceeded tanker arrivals.

4/ Six tankers that arrived to the Offshore Berth, departed via LA 172. Therefore, tanker departures exceeded tanker arrivals.

Berth #4 had 104 tanker arrivals from foreign nations which was more than twice the number of arrivals of the next most frequented docks, LA 45-47 and LB 118-120 with 47 tanker arrivals each. The offshore berth also had the most number of departures for foreign countries. It should be re-emphasized at this point that if the number of domestic coastal tanker departures and arrivals to and from domestic ports, respectively, were added to the totals of Table 4-2, the 1976 vessel frequencies of the individual docks would increase substantially (with the exception of the offshore berth at Huntington Beach with a domestic/foreign total of 23 arrivals in 1976). However, with emphasis placed strictly on sludge exportation, the tanker frequency (of vessels departing for foreign nations) represented a limiting factor governing the potential for a backhaul scheme of sludge loading within normal tanker turn-around times at those docks of Table 4-2 that have only a few tanker departures per year (to foreign nations). Therefore, emphasis was shifted from a per oil dock to a per tanker fleet approach. Table 4-3 gives the total number of tankers distinguished by nation that arrived and/or departed the POLA, the POLB, and the Harbor Complex in 1976. The table also distinguishes the totals for the entire LA/OMA Project region, and it retains the totals from Table 4-2 for the off-shore berths.

From Table 4-3, the number of tankers in the "1976 fleet" to and from any one nation become more meaningful figures. In review of the number of departures to foreign nations, 150 tankers or almost half of the 314 tankers departing from LA/OMA Project area docks "sailed" for Indonesia. In actuality however, it can be assumed that the number of departures to Indonesia was closer to the number of arrivals from that country. This assumption is valid because the differential number of tankers typically departed from the Harbor Complex for Indonesia via Japan (23 ships, that

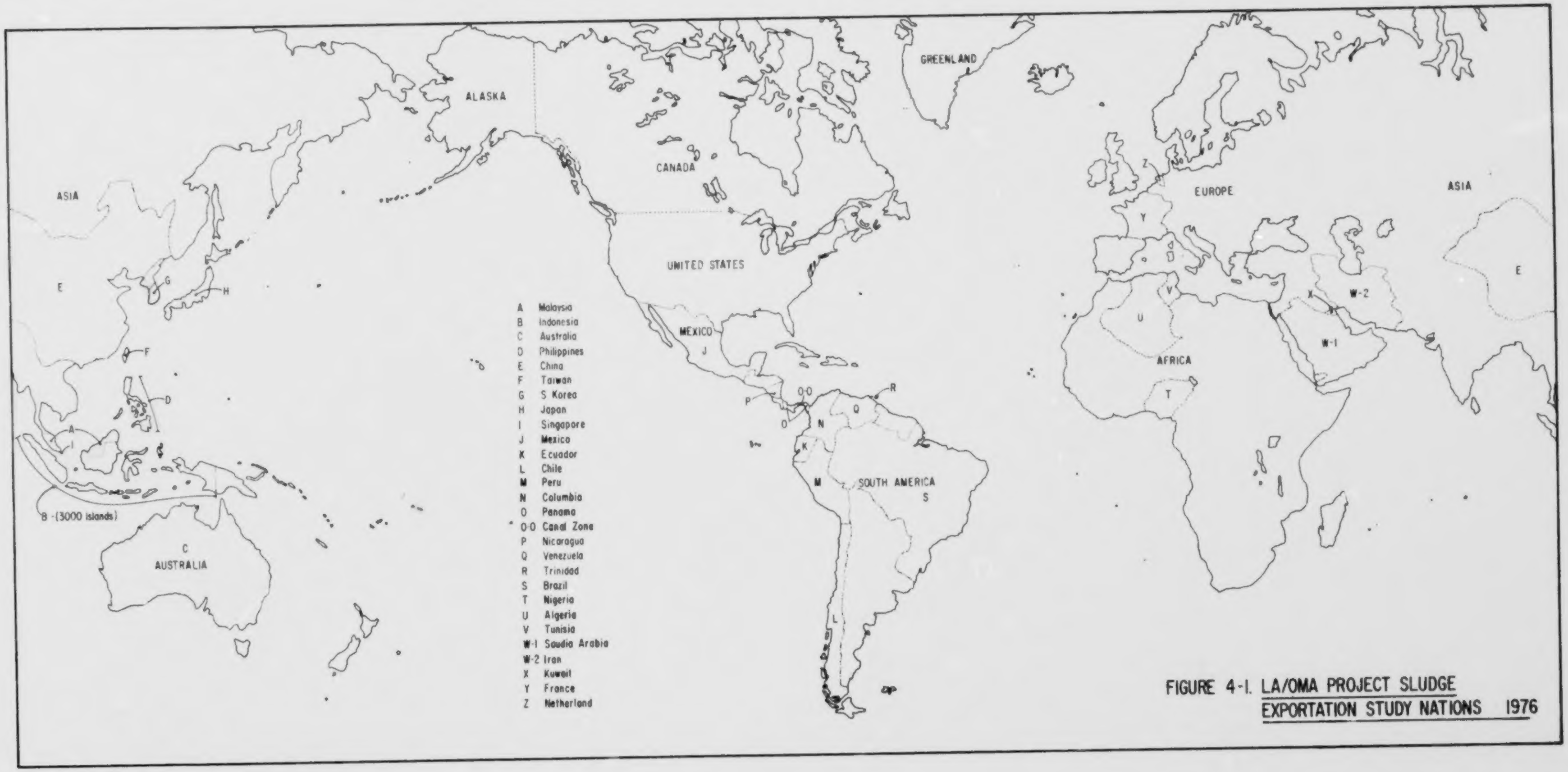


FIGURE 4-1. LA/OMA PROJECT SLUDGE EXPORTATION STUDY NATIONS 1976

probably stopped for new travel orders, bunkers, or repairs), or that sailed via Singapore (25 ships, that probably stopped for bunkers) (9). With regard to the other foreign countries of Table 4-3, however, the departure totals from LA/OMA Project area docks, represent the actual number of tanker departures notwithstanding that some of the individual totals may only represent a number of passage or bunkering stops, e.g. the Canal Zone was recorded to have received 7 tankers.

TABLE 4-3 TANKER ARRIVALS/DEPARTURES - 1976 TOTALS 1/

	Tankers Arriving From (#):	Tankers Departing To (#):
Port Of Los Angeles		
	Indonesia (59) 43%	Indonesia (45) 33%
	Saudia Arabia (30) 22%	Saudia Arabia (27) 20%
	Mexico (13)	Singapore (14) 10%
	Venezuela (6)	Japan (14) 10%
	Japan (9)	Mexico (10)
	Chile (3)	Canal Zone (6)
	Trinidad (3)	Ecuador (5)
	Malaysia (2)	Venezuela (5)
	Singapore (2)	Malaysia (2)
	Iran (2)	Colombia (2)
	Colombia (1)	Taiwan (1)
	Ecuador (1)	China (1)
	Philippines (1)	Kuwait (1)
	Algeria (1)	Brazil (1)
	Nigeria (1)	Trinidad (1)
	Canal Zone (1)	Panama (1)
	France (1)	Netherlands (1)
	South Korea (1)	
Port of Long Beach		
	Indonesia (50) 53%	Iran (15) 23%
	Iran (11) 12%	Indonesia (11) 17%
	Ecuador (10) 11%	Singapore (11) 17%
	Saudia Arabia (7)	Japan (9) 14%
	Nigeria (8)	Ecuador (7) 11%
	Trinidad (2)	Trinidad (4)
	Canal Zone (1)	Saudia Arabia (2)
	Tunisia (1)	Peru (1)
	Japan (1)	Netherlands (1)
	Venezuela (1)	Australia (1)
	Kuwait (1)	Nicaragua (1)
	Philippines (1)	Canal Zone (1)
POLA/POLB Harbor Complex		
	Indonesia (109) 47%	Indonesia (56) 28%
	Saudia Arabia (37) 16%	Saudia Arabia (29) 14%
	Iran (13)	Singapore (25) 12%
	Mexico (13)	Japan (23) 11%
	Ecuador (11)	Iran (15)
	Japan (10)	Ecuador (12)
	Nigeria (9)	Mexico (10)

	Tankers Arriving From (#):	Tankers Departing To (#):
POLA/POLB Harbor Complex (con't)		
	Venezuela (7)	Canal Zone (7)
	Trinidad (5)	Trinidad (5)
	Chile (3)	Venezuela (5)
	Malaysia (2)	Malaysia (2)
	Singapore (2)	Colombia (2)
	Philippines (2)	Netherlands (2)
	Canal Zone (2)	Taiwan (1)
	Colombia (1)	China (1)
	Algeria (1)	Kuwait (1)
	Tunisia (1)	Brazil (1)
	Kuwait (1)	Panama (1)
	France (1)	Peru (1)
	South Korea (1)	Australia (1)
		Nicaragua (1)
El Segundo Offshore Berth #4		
	Indonesia (97) 93%	Indonesia (94) 95%
	Saudia Arabia (6)	Saudia Arabia (5)
	Malaysia (1)	
Huntington Beach Offshore Berth		
	Saudia Arabia (17) 85%	Saudia Arabia (11) 79%
	Ecuador (3)	Ecuador (3)
Total, LA/OMA Project Area Petroleum Berths		
	Indonesia (206) 58%	Indonesia (150) 48%
	Saudia Arabia (60) 17%	Saudia Arabia (45) 14%
	Ecuador (14)	Singapore (25)
	Iran (13)	Japan (23)
	Mexico (13)	Ecuador (15)
	Japan (10)	Iran (15)
	Nigeria (9)	Mexico (10)
	Venezuela (7)	Canal Zone (7)
	Trinidad (5)	Trinidad (5)
	Chile (3)	Venezuela (5)
	Malaysia (3)	Malaysia (2)
	Singapore (2)	Netherlands (2)
	Philippines (2)	Colombia (2)
	Canal Zone (2)	Taiwan (1)
	Colombia (1)	China (1)
	Algeria (1)	Kuwait (1)
	Tunisia (1)	Brazil (1)
	Kuwait (1)	Panama (1)
	France (1)	Peru (1)
	South Korea (1)	Australia (1)
		Nicaragua (1)

1/ Frequencies derived from the compilation of data on tanker activity.

CHAPTER 5

TANKER SIZES AND CAPACITIES

SLUDGE GENERATION AND TANKER CAPACITY

To distinguish the size and capacity of the tankers that departed LA/OMA Project area docks for foreign nations in 1976, the sizes, and cargo and ballast tank capacities (of the tankers included in the data compilation on tanker activity) were documented. The capacity data was extracted from the 1976 Tanker Register (H. Clarkson and Co., London) and the 1976 Shipping Register (The American Bureau of Shipping). In addition, other tanker characteristics such as hull drafts and pumping capacities were documented for reference. It should be noted that previous studies had defined tanker capacity in terms of revenue tons of petroleum imported only, whereas the above references give total capacities of the tankers (10).

As mentioned above, tanker departure frequency was found to be a critical parameter in the assessment of an existing dock's potential for a backhaul (cargo unloading/sludge loading) scheme. However, it is conceivable that a dock with few departures to a foreign nation could still be considered as a candidate for sludge loading operations if the dock's departing tankers could transport a significant volume of the LA/OMA Project sludge. Table 5-1 discloses the amount of sludge that would have to be handled in the future (11).

To assess the relative importance of tanker departure frequency, LA 45-47 with 23 tanker departures to Indonesia (the largest number of departures of any dock except Offshore Berth #4 of Standard Oil) was analyzed in terms of tanker capacity. From the data, it was determined that the 23 tankers (averaging 91,000 DWTs) would provide approximately 2.30 million wet tons per year or nearly 1.50 million gallons per day (MGD) of cargo capacity and 1,400,000 bbls/yr or 0.2 MGD of ballast capacity. In comparing these capacities to the volumes of sludge compiled in Table 5-1, it can be seen that there is only enough cargo capacity (1.5 MGD) to handle the primary or secondary sludges of any one plant (except the primary sludge of JWPCP) for the year 1985. Furthermore, the amount of segregated ballast capacity available is small. Thus, although the individual tankers have great capacities, 23 tankers can offer only a short-term sludge transport potential (assuming enough storage capacity would be available for the sludge between tanker departures). Accordingly therefore, tanker frequency can be considered the most important element in the assessment of a backhaul operation.

TABLE 5-1 SLUDGE QUANTITIES FROM LA/OMA PROJECT AREA PLANTS

	Quantities/Year[1]					
	1985		2000		2020	
	Dry Tons		Dry Tons		Dry Tons	
	Day	MGD	Day	MGD	Day	MGD
I. City of Los Angeles Hyperion Treatment Plant						
Primary	289	1.39	318	1.53	318	1.53
Secondary	205	1.40	222	1.52	222	1.52
TOTAL:	494	2.8	540	3.0	540	3.0
II. City of Los Angeles Terminal Island Sewage Treatment Plant						
Primary	12	0.04	N/A[2]	N/A	31	0.15
Secondary	13	0.33	N/A	N/A	31	0.92
TOTAL:	25[3]	0.40[3]	N/A	N/A	62[4]	1.1 [4]
III. Los Angeles County Sanitation District Joint Water Pollution Control Plant						
Primary	539	2.59	595	2.85	669	3.21
Secondary	160	1.10	175	1.20	183	1.25
TOTAL:	699	3.7	770	4.1	852	4.5
IV. Orange County Sanitation District Plant #1 and #2						
Primary	198	0.95	262	1.26	325	1.56
Secondary	138	0.95	178	1.22	216	1.48
TOTAL:	336	1.9	440	2.5	541	3.0
V. LA/OMA PROJECT AREA TOTALS:[5]	1529	8.4	1750	9.6	1933	10.5

[1] Assumed % solids of 5% for primary sludge, 3.5% for thickened waste activated sludge and 3% for digested combined sludge.

[2] N/A means not available.

[3] Totals for the year 1980.

[4] Totals for the year 1992.

[5] Totals exclude Terminal Island Sewage Treatment Plant.

BACKHAUL FLEET SIZE AND CAPACITIES

It can be seen from Table 4-3 and Figure 4-1 above that the majority of the tankers in 1976 sailed (via the Pacific Ocean) to the Indonesian area, to Iran and Saudia Arabia (of the Persian Gulf area), and (via the Panama Canal) to the northernmost nations of South America, world regions 1, 2, and 3, respectively. With emphasis on formulating adequate tanker frequencies, five combinations of tanker "fleets" to these three regions of the world can be identified. They include:

Fleet 1: (Indonesia)	POLA/POLB Harbor Complex to Region 1; Includes 83 tankers; departing to Indonesia (56), Singapore (25), and Malaysia (2).
Fleet 2: (Indonesia)	El Segundo Offshore Berth #4 to Region 1; Includes 94 tankers; departing to Indonesia (94).
Fleet 1 + 2: (Indonesia)	LA/OMA Project Area to Region 1; Fleet 1 plus Fleet 2; 177 tankers.
Fleet 3: (Latin America, South America)	LA/OMA Project Area to Region 2; Includes 38 tankers; departing to Ecuador (15), Canal Zone (7), Trinidad (5), Venezuela (5), Colombia (2), Brazil (1), Peru (1), Panama (1), and Nicaragua (1).
Fleet 4: (Persian Gulf)	LA/OMA Project Area to Region 3; Includes 61 tankers; departing to Saudia Arabia (45), Iran (15), and Kuwait (1).

Utilizing the data compilations, the fleet capacities to the three regions for the year 1976 were computed. Figure 5-1 gives the total fleet cargo and ballast capacities to the three regions of the world. Figure 5-2 gives the approximate monthly frequencies of the tankers that departed to Region 1 in 1976.

Referring to Table 5-1 above, the individual fleet capacities of Figure 5-1 can be reviewed in terms of their capacity to handle sludge. Fleet 1 with an average cargo capacity of 5.85 MGD (or 8,905,000 tons/year), has sufficient capacity for the sludge of any one LA/OMA Project area wastewater plant for the year 2020. Fleet 2 with an average cargo capacity of 9.38 MGD (or 14,277,000 tons/year), also has the necessary capacity for any single plant in the year 2020, and the fleet could handle all the LA/OMA Project area plant combined in 1985. The combined fleet (Fleet 1 + 2) to the Indonesian region with and an average cargo capacity of 15.23 MGD (or 23,182,000 tons/year), has enough capacity for all of the LA/OMA Project area sludge anticipated for the year 2020. Therefore, enough fleet cargo capacity exists to Region 1, however, the average segregated ballast fleet capacities (Fleet 1 @ 0.62 MGD, Fleet 2 @ 1.06 MGD, or Fleet 1 + 2 @ 1.68 MGD) provide only around 10% of the cargo capacity, which are insufficient volumes for the total amount of sludge generated at any LA/OMA Project area plant in 1985. However, the segregated ballast capacities are sufficient to handle a large fraction of the sludge produced by an individual plant, e.g. Fleet 1 + 2 has enough ballast volume for 56% of the total amount of sludge anticipated to be generated by Hyperion in the year 2020. Further, the segregated ballast capacity of Fleet 1 + 2 is sufficient for all the sludge of the Terminal Island Sewage Treatment Plant in 1992.

With regard to Region 2, Fleet 3 has neither the cargo (1.62 MGD) nor the ballast capacity for the 1985 total and per plant sludge volumes. However, Fleet 4 to Region 4 with an average cargo capacity of 4.50 MGD, has sufficient capacity for the sludge of Hyperion, or the CSDOC plants through the year 2020, or the JWPCP through 2000. The ballast volumes available (Fleet 3: 0.12MGD, and Fleet 4: 0.54 MGD) are not adequate for the total per plant sludge volumes of Table 5-1. However, Fleet 4 has enough ballast volume available for 28% of the CSDOC Plant 1 and 2 sludge expected in 1985.

Several assumptions and facts governing the fleet/sludge volume comparisons should be noted or re-emphasized at this point. They include:

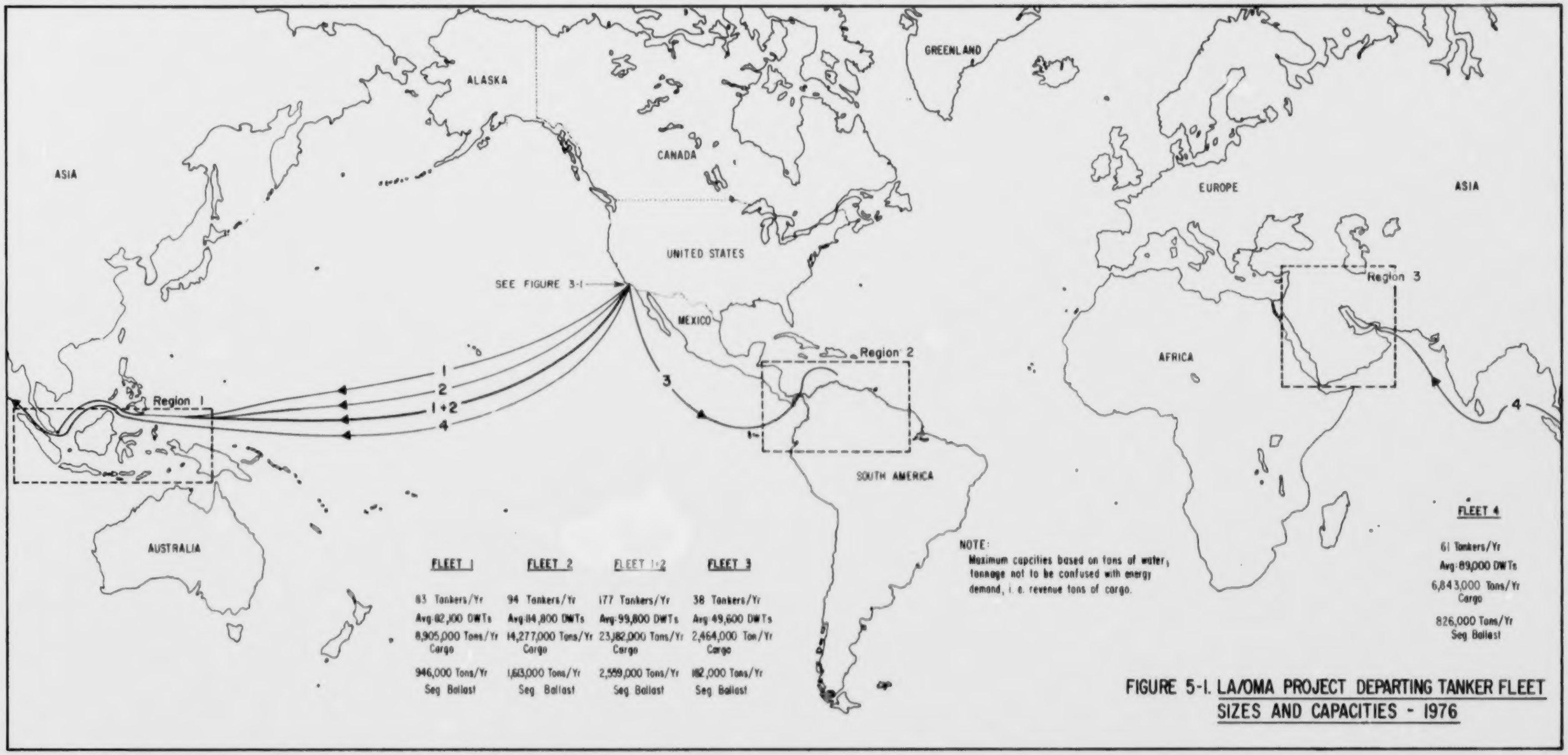
(1) The tanker capacities represent fleet totals for the year 1976; sludge volumes were documented for the year 1985, 2000, and 2020.

(2) Fleet 1 and Fleet 1 + 2 exclude the tankers that were documented to be departing for Japan; approximately 2,363,000 tons/day or nearly 1.55 MGD of capacity could be added to the totals for Fleet 1 and Fleet 1 + 2 if these tankers were assumed to have gone to Region 1.

(3) The fleets were composed without regard to the dock(s) where backhaul sludge loading would take place.

(4) The fleet capacities were computed on a per region basis, i.e. the tankers that departed for the Persian Gulf were assumed to pass through Indonesia (not available for sludge unloading in Indonesia).

Therefore, it should be understood that the capacities of the above fleets (1976) may not be representative of the 1985 fleet capacities, or of the twenty-first century fleet capacities. Chapter 6 discusses some of the constraints governing the size of the tanker fleets potentially available for a backhaul scheme.



FLEET 1	FLEET 2	FLEET 1+2	FLEET 3	FLEET 4
83 Tankers/Yr	94 Tankers/Yr	177 Tankers/Yr	38 Tankers/Yr	61 Tankers/Yr
Avg:82,100 DWTs	Avg:114,800 DWTs	Avg:99,800 DWTs	Avg:49,600 DWTs	Avg:89,000 DWTs
8,905,000 Tons/Yr Cargo	14,277,000 Tons/Yr Cargo	23,182,000 Tons/Yr Cargo	2,464,000 Ton/Yr Cargo	6,843,000 Tons/Yr Cargo
946,000 Tons/Yr Seg Ballast	1,613,000 Tons/Yr Seg Ballast	2,559,000 Tons/Yr Seg Ballast	182,000 Tons/Yr Seg Ballast	826,000 Tons/Yr Seg Ballast

NOTE:
Maximum capcities based on tons of water, tonnage not to be confused with energy demand, i. e. revenue tons of cargo.

FIGURE 5-1. LA/OMA PROJECT DEPARTING TANKER FLEET SIZES AND CAPACITIES - 1976

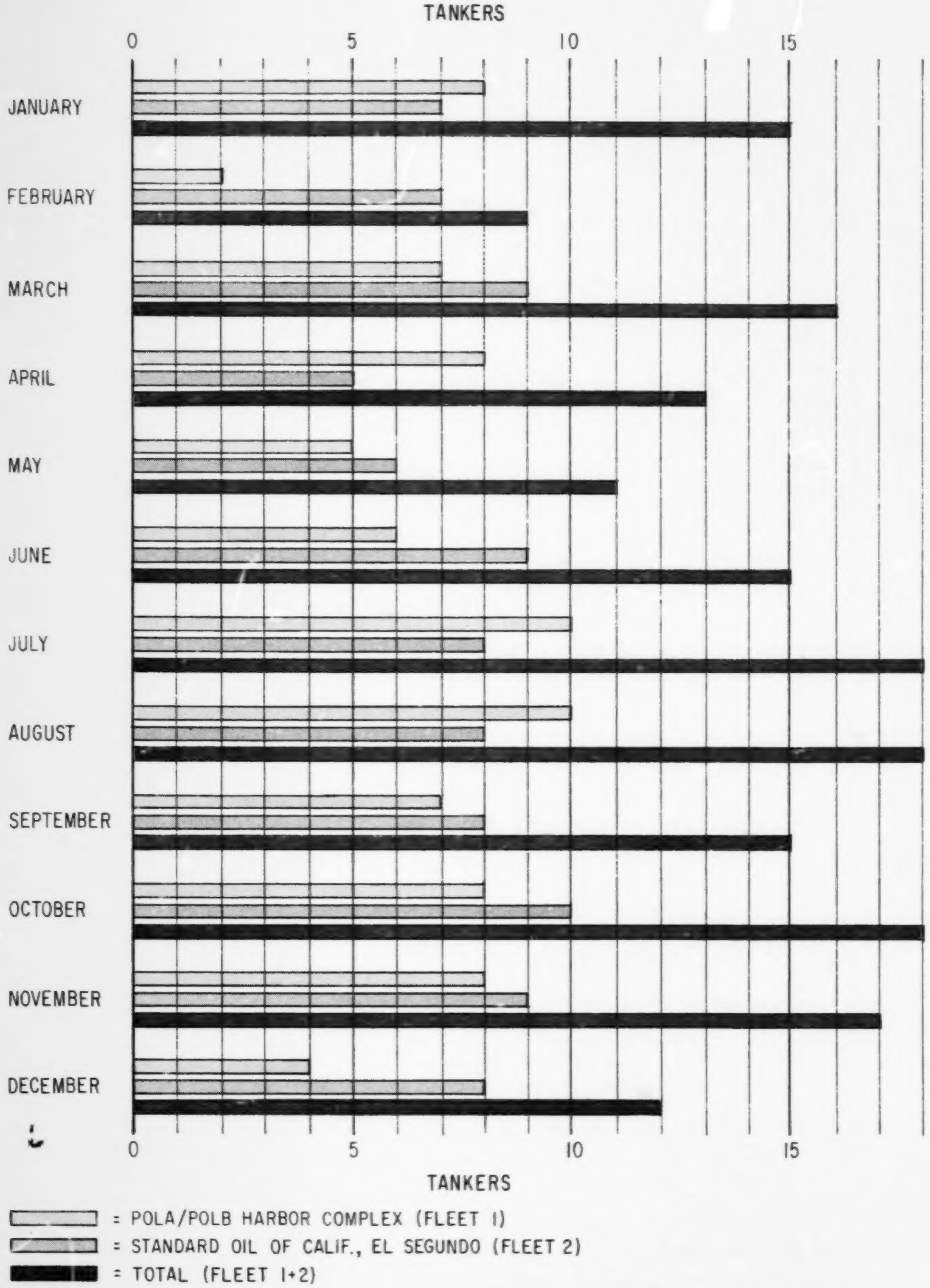


FIGURE 5-2. FLEET 1+2 DEPARTURE FREQUENCY TO REGION 1

NOTE: The largest gap between ships was 6 days in February 1976

CHAPTER 6

TECHNOLOGICAL AND INSTITUTIONAL CONSIDERATIONS GOVERNING THE BACKHAUL ALTERNATIVE

TECHNICAL CONSIDERATIONS

North Slope Crude and Tanker Availability

Since the pipeline to transport the Alaskan North Slope crude oil (primarily Pruhdoe Bay crude which began flowing June 20, 1977) was built to a southern Alaska terminus at the Gulf of Alaska of the North Pacific Ocean, California became a market for the crude to be transported by tankers. However, this crude oil is both heavier in quantity and higher in sulfur content than the average of the imported crude oils in 1975 which were processed in California. Therefore, the ability of California refineries to process the North Slope oil is limited. Further, only a fraction of the crude is needed in California until 1990 when the state's indigenous crude production will begin a decline (12). Hence, the dominant factors affecting the use of North Slope crude oil in California are as follows (13):

(1) Willingness of refiners to make de-sulfuring equipment investments in existing plants.
(2) Ease of disposal of surplus crude, and
(3) Domestic and/or foreign exchange potential.

In addition, the price of the North Slope crude, government mandates, and corporate considerations will affect the amount of crude delivered to California (14).

In review of the impact of the North Slope crude on California, A.D. Little, Inc., has made an analysis of the ability of refineries to process the North Slope crude. Based on the quality characteristics of 1975 crude imports to California alone, the firm concluded that 60-90% of the North Slope crude could have replaced imports in 1975 (15). Therefore, it is obvious that the number of tankers arriving with imported oil could decline significantly in the near term.

To estimate what the actual impact will be on tankers from foreign nations, opinions and/or actual plans governing tanker fleets were solicited from personnel of the major LA/OMA Project area crude importing oil companies. In the POLA/POLB Harbor Complex, Texaco, Inc., plans to continue to import Indonesian crude (16), while Union and Mobil Oil have disclosed that it is too early to predict the impact on their facilities (17). Likewise, Gulf Oil has disclosed that the firm does not know at this time what changes will occur at their offshore Huntington Beach berth

(18). However, the planning department director of Standard Oil of California at El Segundo has disclosed that Phase 1 of their plans will probably result in a 50% reduction of the Saudia Arabian oil that is brought to El Segundo on lightered vessels (operating from San Clemente Island, these tankers did not arrive at Berth #4), i.e. the Arabian oil is to be replaced by the Alaskan oil. Furthermore, Standard Oil expects the Indonesia oil imported to diminish by 50% if for no other reason, because Indonesian production is expected to decrease (19). It should be noted that the consensus of opinions solicited did suggest that total foreign imports will decrease significantly during the years the Alaskan North Slope is producing.

Tanker Pumps

It has been the practice for the tankers of the size that arrived at LA/OMA Project area docks in 1976 to have steam turbine main propulsion, which means that these ships have ample high pressure super-heated steam available for driving the oil pumping machinery. This, coupled with the need for higher discharge rates, has resulted in the general use of steam turbine driven horizontal and vertical centrifugal pumps for handling the cargoes in these ships (20). Likewise, the ballast tank pumps are typically centrifugal pumps. It should be noted that a few of the tankers that arrived in 1976 could be expected to also have horizontal, vertical simplex, and duplex, direct-acting reciprocating pumps, as well as horizontal and vertical duplex and triplex power pumps. Further, on the older tankers, some direct-acting steam pumps may be found. Finally, self-priming rotary (positive displacement) pumps are commonly used as "stripping" pumps to drain the last few feet of cargo in the compartments of most tankers (21).

Tanker centrifugal cargo pumps are usually of the non-self-priming type used in conjunction with the positive displacement stripping pumps, and they may either be single or multi-staged. The stripping pumps are usually either vertical or horizontal duplex steam driven types similar to the cargo pumps, however, stripping pumps must be of extremely robust construction to deal with crude oil sludge (grit and wax) often encountered when crude oil is handled (22).

In review of the potential for tanker pumps to handle sewage sludge, two critical pump characteristics are most evident. First, the centrifugal pumps may have impellors, or impellor vanes, that may not allow passage of some particles found in sludge or that may allow sludge to accumulate on the vanes. Second, the centrifugal volute or turbine and the rotary pumps may have column assemblies with internal bearings that are cargo lubricating, e.g. with crude oil. The latter may be considered the most serious constraint governing the use of tanker pumps to transfer sludge, i.e. the hair and abrasive particles of sludge could be expected to destroy such internal bearings (23). Therefore, a water or oil lube line may have to be retrofitted on such pumps. The former constraint, however, may be of marginal significance since impellor clearances (as large as 2½") may be adequate for the particle sizes expected in sludge (24). However, multi-stage and/or multi-impellor-vane tanker pumps could be subjected to extreme wear from sludge handling and clogging (25). Likewise, tanker pumps wear rings (with close tolerances) may be damaged (26). Thus, sludge screening to 0.10 inches may be necessary prior to sludge loading (27), as opposed to an impellor switch which may reduce the pump discharge rate.

With regard to tanker pump performance, the sludge is expected to be readily pumpable (up to 3.5% solids (28)). Assuming a crude vapor pressure of as high as 7.4 psi @ 73°F versus a sludge vapor pressure of around 0.25 psi @ 60°F, no NPSH, cavitation, or vortexing problems are anticipated (29).

Finally, problems might be expected along the tanker piping systems. The cargo flow to a pump typically passes through a ½"-mesh strainer and "mud box" adjacent to each pump which could become clogged by the sludge (30). Further, the bends of the piping system may facilitate the settling or precipitation of some sludge constituents. With consideration given to maintenance, and to the fact that pumping duration and frequency should be small, such problems may be expected to be insignificant, e.g. the pipelines could be flushed with water.

In conclusion, the high-volume, high-head tanker pumps were not made for sewage sludge applications. Therefore, a backhaul scheme of sludge handling could not be expected to make use of every tanker arriving at LA/OMA Project area docks. Assuming that an economic incentive exists, operators may be motivated to make the necessary vessel changes e.g. new tanker pumps.

Cargo Tank Cleaning

Almost all of the tankers that arrive are typically large crude oil carriers chartered by the oil companies. Since these tankers return for a new load of crude (and not a different cargo, e.g. gasoline) tank cleaning is not necessary because the new load would not be contaminated by the residue crude left in the cargo tanks after discharge. However, if a tanker must have some cargo tanks administratively dedicated to ballast (not physically segregated ballast tanks), the chosen ballast tanks must be cleaned prior to ballasting. Otherwise, the residue crude will contaminant the seawater ballast, and the discharge of this ballast at the loading port would create water pollution. It should be noted that tank cleaning is necessary on all tankers periodically so that sediment, e.g. crude oil paraffin, does not accumulate to excessive amounts. Such routine cleaning is typically done on a rotating basis with the individual tanks cleaned over a series of voyages. Finally, on occasion an individual must enter each cargo tank to inspect and/or repair tank elements, e.g. valves. Prior to entering a tank, the tank must not only be washed, but for safety reasons, the tank must also be certified by a marine chemist to be "gas free", i.e. no significant amount of hydrocarbon vapor consisting of the light ends of residue crude would be left in the tank.

It appears evident in the case of an instituted backhaul scheme, that the cargo tanks would have to be cleaned after sludge unloading and may perhaps also need to be cleaned prior to sludge loading. Approximately 0.08 to 0.5% of the amount of cargo originally loaded will remain in the cargo tanks as clingage and residue after discharge (depending on the nature of the product carried)(31). Therefore, assuming 0.5% of the cargo was left in the cargo tanks after discharge, a 5000 ppm increment of "oil" would be added to the loaded sludge (assuming that the tanker was loaded to the same level that the crude had been loaded and that all the residue crude mixed with the sludge). The size of this oil increment is reasonable because ship tankers do not pump the tanks past certain gauged levels, and because some tankers unload only the crude they have time to discharge at docks that must facilitate tankers at high tide.

The oil and grease content of LA/OMA Project area raw sludge is typically around 10,000 ppm, while digested sludge averages less than 5000 ppm (32). Thus, if the crude residue was mixed with digested sludge, the resulting concentration would probably be less than or equal to the oil and grease content typical of raw sludge. However, the greater fraction of the oil and grease content of raw sludge consists of grease. Therefore, the loaded sludge would gain a substantial amount of crude oil which is not easily biodegradable and that has toxic properties -- an undesirable addition to sludge that might be marketed as fertilizer but not necessarily incompatible if the sludge was used only as a soil amendment. Therefore, it appears that it would be preferrable to clean the cargo tanks prior to sludge loading (in conjunction with oil recovery). This cleaning would most likely be in conjunction with the recovery of soluble oil e.g. a 100,000 DWT tanker with 0.5% of its original cargo recovered would yield a $35,000 residual oil credit at $10/bbl.

With regard to tank cleaning after sludge unloading, sludge clingage is expected to be minimal in comparison to heavier crude clingage (sludge clingage to sewage plant anaerobic digestor tanks is found to be small when the tanks are entered for cleaning (33)), however the grease and "grit" residue left in a cargo tank that is not completely discharged would contaminate the new cargo of crude to some degree. Assuming that 0.5% of the original sludge was retained as tank clingage and residue, a 150 ppm increment of solids would be added to the loaded crude which typically has only a 0.05 to 0.10% (500-100 ppm) solids and water content ("S and W" total, comprised primarily of water). Excessive S and W fouls refinery catalysts and desulfuring units, and the excess causes an emulsified layer to accumulate on the refinery desalters (34). However, laboratory personnel of Standard Oil of California have disclosed that the plant processes will handle up to 2% (20,000 ppm) S and W crude content, but that it is unlikely that they would allow such a crude to be processed, i.e. even the average crude with 0.05 to 0.10% S and W is decanted and most grit is removed. Since the water content of sludge cannot be readily decanted by an oil water separator, a 150 ppm sludge increment may reduce the trouble-free, processing "insurance" a refinery has in refining crude relatively free of solids and water. Nevertheless, given that the sludge S and W increment is small, it appears that the cargo tanks may not have to be cleaned prior to the loading of crude. If tank cleaning is necessary for sludge or crude removal, it can be done using fixed or portable machines that direct high-pressure jets of sea water around the inside of the tank such that those surfaces not directly hit and cleared are washed by the splash from surrounding structure.

Figure 6-1 shows two tanker cargo compartments (tanks) with portable "Butterworthing" (washing machine) units operating in the compartments. As water is delivered up to 180 psi and 180°F into the tanks, it must be removed progressively, together with the oil and sediment it dislodges. This is done by stripping constantly using either main reciprocating pumps or stripping pumps in ships with main centrifugal pumps (35). The strippings may be discharged into any one of the ship's cargo compartments known as the slop tank -- or directly overside to sea.

Typical of tanker operations today, the water from one slop tank is slowly drained to sea leaving only recovered oil emulsified with some salt-water in the slop tank, and crude is later loaded on top of the recovered oil (36).

Unfortunately, the water of sludge washings could not be drained in the same manner. Rather, the slop tank would have to retain "diluted sludge" for on-shore disposal unless such washings were allowed to be dumped at sea. However, if the sludge unloading took place at the crude oil loading dock, the tanker would probably have to depart for the open ocean to dump the tank washings and then return to load crude.

Finally, it should be noted from Figure 6-1 above that the many structures of the compartments inevitably retain some residue after washing (37). Thus, there may be some health cautions associated with tank inspections when an individual enters a tank.

Use of Segregated Ballast Tanks

As disclosed in the Introduction, segregated ballast is a system in which specific tanks aboard ship are designated solely for ballasting (typically the wing tanks). Some new tankers currently have as much as 30 percent of their total deadweight tonnage designated for this purpose (38), although the tankers that arrived from foreign nations to LA/OMA Project area docks in 1976 averaged only 7 to 11% segregation. Tankers with segregated ballast typically have a separate pipeline system, and a separate

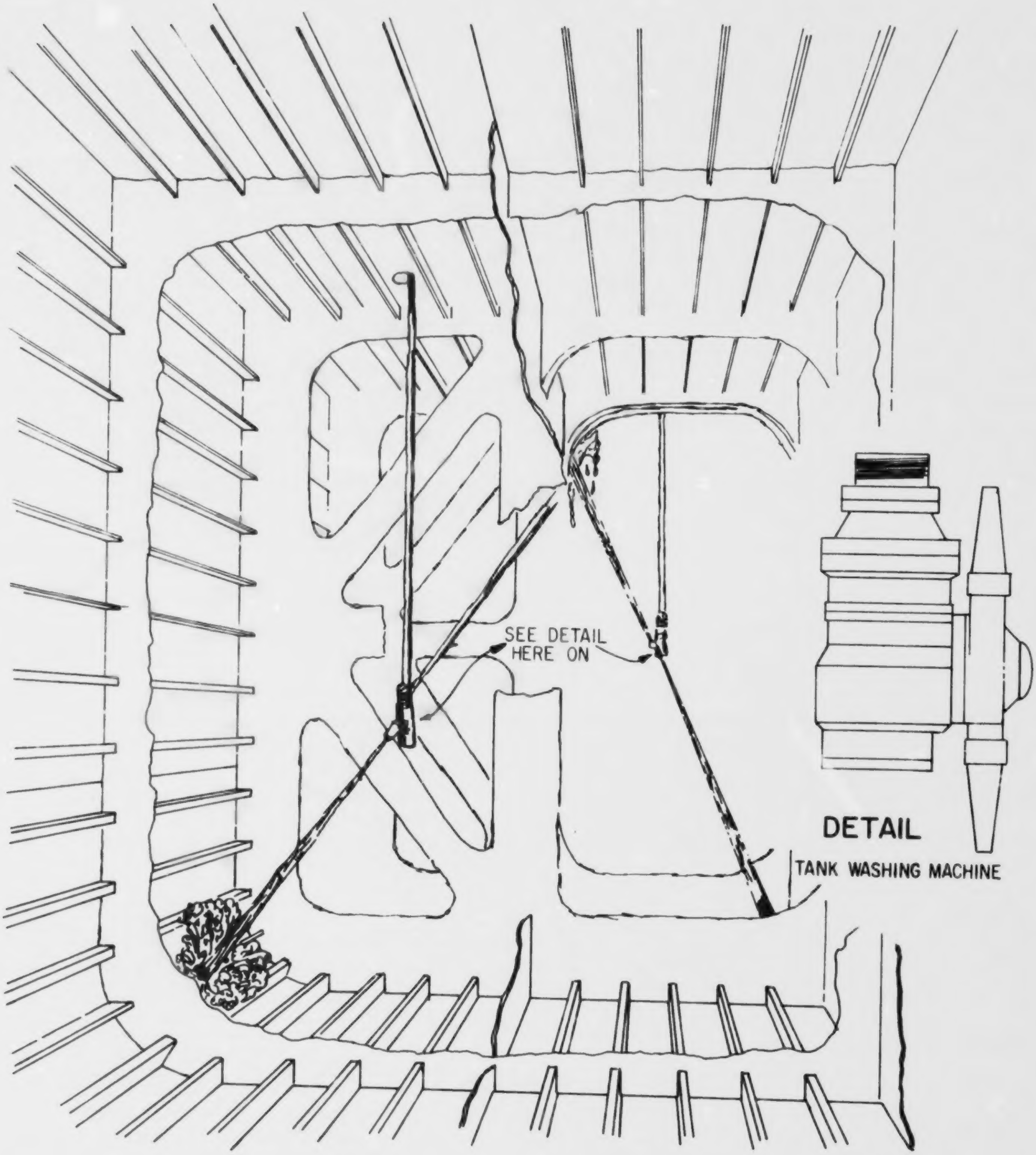


FIGURE 6-1. TANK CLEANING MACHINE OPERATING IN CARGO COMPARTMENTS

Drawing excludes compartment pipes, valves, and heating coils.

Source: From Butterworth Systems, Inc., tank cleaning machine literature; obtained from Todd Shipyards, Inc.

centrifugal pump. Therefore, the advantages of this system are at once obvious, i.e. with a completely separate ballast system, cargo and ballast can be handled simultaneously so that expensive delays at loading and discharge ports are reduced to a minimum. At the crude loading terminal, for example, crude cargo work could commence as soon as the vessel arrives at the dock. The ships that left LA/OMA Project area docks in 1976 normally leave with the permanent ballast tanks full plus some extra ballast in several of the cargo tanks since the vessels cannot be completely segregated (7-11% average with as much as 100% of the total tanker capacity needed for ballast at sea). If the amount of cargo volume used for ballast is kept to a minimum, it can be discharged by the time the crude loading arms are connected. The crude loading can then begin concurrently with segregated ballast discharge. Therefore, it is apparent that sludge used as ballast in the segregated tanks might be discharged in the same manner and time frame at the crude loading port.

There is a problem however with sludge transfer to shore. The independent pumping system of the segregated ballast tanks, by virtue of its purpose, only pumps in or pumps out seawater from the bottom or the side of the tanker. Thus, a means of getting the sludge removed from these tanks would have to be incorporated. Some tankers have pipelines from these tanks to the tanker deck unloading/loading manifold, e.g. ARCO's tankers are equipped with such lines to remove ballast water that may become contaminated if a cargo bulkhead broke (39). However, one tanker of every two probably does not have such a line (40). Therefore, if a backhaul scheme was instituted utilizing segregated ballast tanks for sludge, it could be expected that only half of the tankers that arrived in 1976 to LA/OMA Project area docks would be available to load sludge in these tanks. It should be noted however, that the majority of the tankers with such independent systems, typically have segregated ballast pumps that have a pressure head as high as 350 feet (41). Therefore, the sludge could be removed from these tankers if the operator(s) agreed to install a pipeline to the deck (around 60-120 feet above the pumprooms). Further, some tankers have pipelines joining the cargo and segregated ballast systems. Such pipelines, or retrofitted pipelines could be used to transfer the sludge via the cargo pumps to the deck. Finally to avoid any retrofitting, large submersible pumps could be lowered into the segregated ballast tanks to remove the sludge (42).

With regard to segregated ballast tank cleaning, a means of removing sludge residue from the tanks would be a necessity at least periodically during tank maintenance. Therefore, a Butterworth-type-system may have to be utilized for this purpose. It could be expected, however, that the tanks could be kept reasonably clean by tanker ballasting and discharging of seawater. Such a cleaning scheme could be instituted during the loaded-crude voyage to Southern California (assuming residue grit/grease did not foul the pumps, which like the cargo pumps, may be cargo lubricating (43)), however such cleaning discharges would be most likely limited to the high seas and not in a port (e.g. the Port of Long Beach does not allow even clean water ballast to be discharged in the harbor because of the human error potential for an oil rather than a ballast discharge (44)).

Tank Corrosion

Many tankers now have the inside surfaces of their cargo tanks entirely coated with epoxy-based paints or with a layer of zinc (coatings usually 2-10 mls in thickness). Such coatings not only control corrosion successfully with routine maintenance, but they also make most tank operations easier, quicker and cleaner, i.e. the coatings cut down the amount of tank cleaning necessary by reducing the amount of residue left behind after discharge.

Perhaps an equal number of the tankers of the world fleet today do not have coated cargo tanks, or they only have some tanks coated (45). However, builders have typically coated tanks to be dedicated to ballast (46). It has been disclosed that many tanker owners, faced with the "bill" for having a tanker built, will make the decision to not spend money on tank coatings until one or two years after the tanker is built, i.e. until after the tanker has generated some revenue (47). Therefore, the rapid formation of rust on steel structures can become apparent typically after heavier grades of oil become mixed with residue left from the last discharge to yield a solidified scale that cannot be removed by ordinary washing methods.

It can be expected that sludge mixed residues would produce similar scaling problems. A barging company in Chicago has found that tuberculation has been apparent on their barges used to transport sludge from the City of Chicago (48). Rust that must be removed by sandblasting is an extremely difficult and expensive job with tanks typically coated afterwards (49). Tankers that have never received protective coatings have remained in service because their crews have manually scraped the rust from the tanks on a periodic basis, or because the tankers have cathodic protection systems that have successfully halted severe tank corrosion. Finally, with regard to tanker pumps, many ship owners have avoided severe corrosion/erosion by utilizing pumps (typically cast iron) with liquid ends made completely of gunmetal.

As a rule-of-thumb, it could be concluded that if the oxygen content of the ullage space remains below 5%, the rate of corrosion should be minimal on non-coated tankers.

In conclusion, therefore, it could be said that tankers with coated tank surfaces and coated internal members, e.g. pipes, would be preferrable for a sludge backhaul alternative.

Sludge Handling and Tanker Safety

After each anaerobic digester of the JWPCP was built and prior to start-up, each digester was filled with water. Then methane gas was introduced into each tank progressively, filling each digester while the water was drained. The resulting tank atmospheres were then in an "inerted" state, and the tanks could therefore be loaded with methane-generating sludge without danger of tank explosion resulting from the ignition of a flammable mixture of hydrocarbon (methane) vapor and oxygen (50). Interestingly enough, less than 10% of the tankers that arrived at LA/OMA Project area docks in 1976 had a shipboard system for inerting tanks prior to crude loading or unloading even though the tanker compartments can similarily be expected to have, or potentially have, dangerous ratios of hydrocarbons and oxygen gas. Hence, the explosion potential of sludge loading and unloading should be considered as another potential constraint that may limit the number of tankers that would be suitable for sludge handling.

Assuming that an explosion could result during sludge loading and unloading, Figure 6-2 illustrates why it may be a good practice to inert tanks prior to sludge handling. The area inside the "hatched" loop of Figure 6-2 represents flammable mixtures in crude tankers while any point outside the loop represents a mixture considered incapable of explosion, e.g. the flammable range narrows as the oxygen decreases to about 11% O_2. If a mixture outside the loop is diluted with air, its composition changes such that it moves along a straight line joining the point representing the original mixture to the origin (pure air). Therefore, line 'OX' passes through the flammable area, and a mixture with an original composition corresponding to 'X' will therefore be flammable for part of the time it is progressively diluted with air. By contrast, the mixture corresponding to point 'Z' will be safe throughout the dilution process since line 'OZ' does not pass through the flammable area. Thus, there is a limiting line 'OY' which just touches the loop, such that compositions above the line 'OY' go through a flammable phase as they are diluted with air. The general situation is that all compositions above the line 'YVW' are either flammable or become flammable at some time during dilution with air (51). It should be noted that the above illustration with an explosive range of 2 to 10% hydrocarbon vapor reflects the critical range consistent with tanks filled with the several individual hydrocarbon gases released from crude oil, and that it is generally believed that for a tank filled with methane only, the explosive limit will actually be between 4.5 to 15% hydrocarbon gas by volume (52). The approximate range of flammability of methane from sludge is also circumvented in Figure 6-2.

Although experience has shown that sludge loading has been practiced safely, e.g. a barging company of Chicago loads sludge on barges without inerting barge tanks (53), it is known that crude oil tankers that do not have inerting systems could be expected to

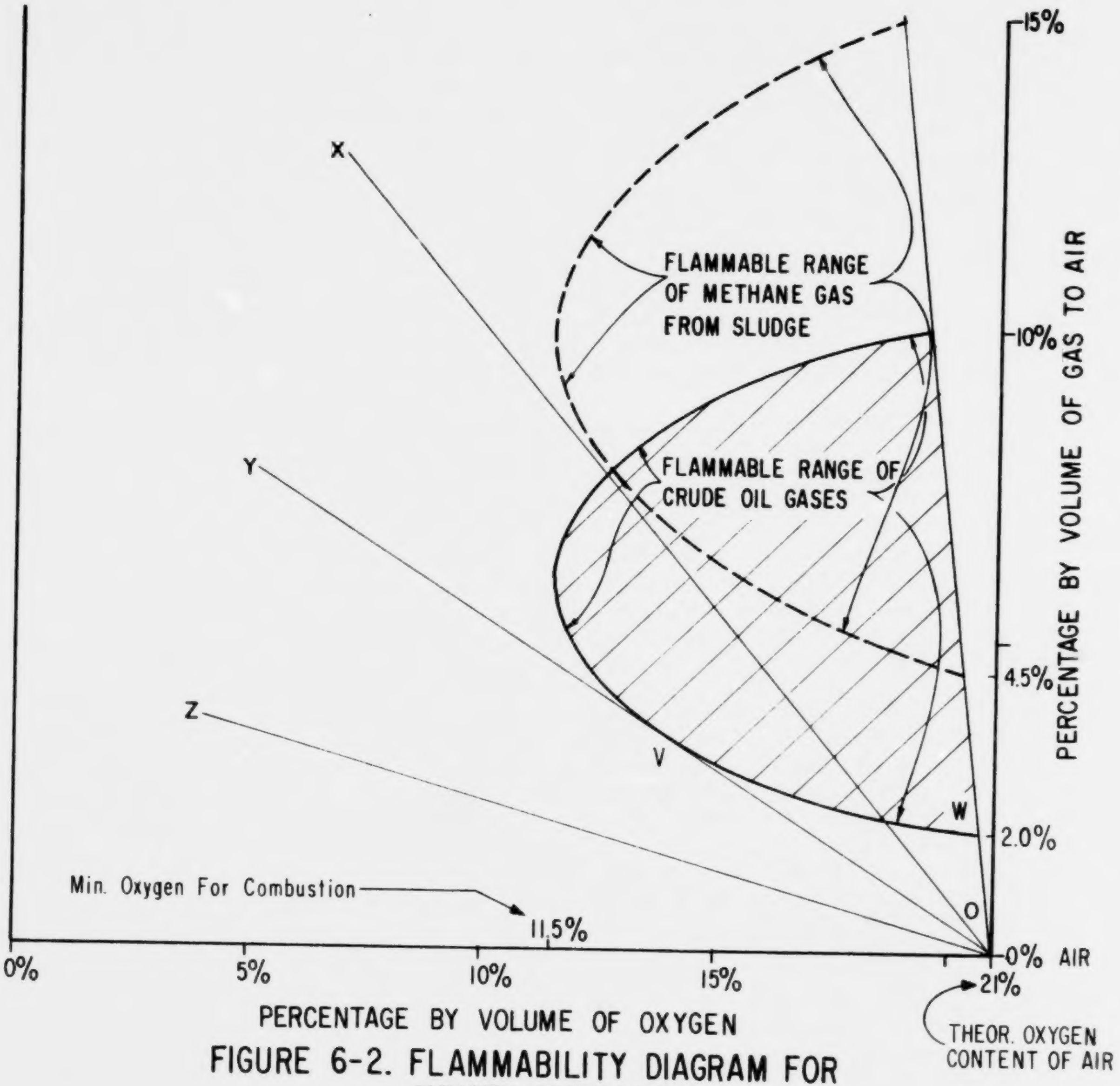


FIGURE 6-2. FLAMMABILITY DIAGRAM FOR OXYGEN HYDROCARBON GAS MIXTURE

Source: Constructed from Figure 6.3 of "The Inert Flue Gas System Operating Instructions", BP Tanker Company, Ltd., July, 1971; from one flammability diagram of "Inert Gas Operating Instructions", Dec., 1975, Shell International, Ltd.; and from methane data disclosed by J. Aspland (ARCO) and M. Morrissette (Cargo and Hazardous Materials Division, U.S. Coast Guard), 7/77.

explode if a source of ignition was evident during crude loading (54). Dangerous fumes not only exist inside the tanks during crude loading or ballasting, but the fumes also "cover" the deck of a tanker as the gases are displaced through pressure relief valves of the deck-level masts or expansion trunks, or through ullage caps that have been removed prior to tank filling (55). (Note: Sludge loading could be expected to produce an odor (mercaptan) problem on deck unless tall masts exist on the tanker.)

With this explosion potential acknowledgement, it should be noted that sewage sludge as cargo would probably be classified by the United States Coast Guard, Hazardous Material Division as a Class C Grade Flammable Cargo (a cargo with a Reid vapor pressure of 8½ lbs or less and a flash point of 80°F or below). This classification, which is for the least dangerous petroleum cargo typically transported, can be anticipated to be placed on LA/OMA Project area sludges because the sludges, even in a digested state, can be expected to produce (due to microbial activity) enough methane in the ullage space (above the sludge surface in a tanker compartment) to leave a tank in a dangerous state (within the flammable range) during sludge transport (56). This sludge classification is anticipated in full recognition of the fact that the sludge (itself) does not qualify as a Grade C substance as said substance is defined technically above, i.e. the Grade C classification would be applied to the sludge because, and only because, the biodegradation of the sludge generates methane gas that would be considered "flammable" (although the gas would probably only cause an explosion, the Coast Guard feels that a tanker fire would still be evident because methane gas burns in the atmosphere). Hence, the Coast Guard classification of Grade D Combustible (a cargo with a flash point of greater than 80°F and less than 150°F (indiscrimminate of vapor pressure and thus labeled "combustible" rather than "flammable")) as it is currently applied to the sludge the Chicago barging company transports, might be subject to a formal, re-classification in the future, i.e. to a Grade C Flammable (57) (although the barges have venting systems with blowers (required by the Coast Guard, as is the employment of certified tankermen)).

Therefore, even if the sludge could be loaded anaerobically to avoid any oxygen purging (while minimizing corrosion) into tanks that may have hydrocarbon vapor present, one could expect that the sludge would still receive a flammable rating because methane will be generated during a tanker's trans-ocean voyage (24 days typically to Indonesia). Appendix C, gives Coast Guard Form #4355 which must be submitted to the Hazardous Material Division before a specific determination is made on the ultimate grade the sludge would be classified.

In conclusion, it should be noted that materials are classified by the Coast Guard on a per-application basis. Thus, the classification that may be given to other sludges, e.g. the sludge of Chicago, may not necessarily be the grade given to one of the LA/OMA Project area sludges. Finally, since oil tanker crews have typically handled cargo tanks with explosive mixtures of gas, it might be expected that sludge pre-transport aeration facilities would not be unnecessary to reduce sludge methane generation. However, this would not hold true for segregated ballast tanks that do not have adequate pressure relief/venting systems, i.e. tanks that only have "goose-neck" pipes that serve to vent the tanks naturally (58).

Tanker Air Pollution

If sludge is loaded into a cargo tank, hydrocarbon gas generated from the residual crude and hydrocarbon gas left in the ullage space of an incoming tanker will be displaced through the deck openings, e.g. ullage ports, (even if the tank was in an inerted condition (59)). This displaced gas would represent the largest source of air pollution from a tanker, and it would most likely have to be collected by a vapor recovery system (VRS), especially if many tankers are to be loaded annually. VRS's for tankers are not in existence currently with the exception of a VRS at the Alaskan pipeline terminus in Valdez. For the purpose of cost estimations in this study, a VRS conceived for the POLB for crude oil unloading (60) was assumed to be a viable VRS for use in a backhaul scheme. It should be noted that during any tank washing, vapor would likewise be displaced.

Dock Water Depth Constraint

Based on water depth and/or tanker draft, a vessel that does not exceed 150,000 DWTs (*Arco Independence* @ 46,496,000 gallons capacity and a 55-foot draft) could be loaded with sludge pumped into the cargo tanks at LB 118 (57 feet) and at El Segundo Berth #4 (56 feet). At Huntington Beach, a vessel of a maximum size of 70,000 DWTs (approximately 21,000,000 gallons capacity and having a 43-foot draft) could be loaded (61). As disclosed above, loading sludge into the cargo tanks would be necessary to transport the 1985 LA/OMA Project area sludge volumes. However, if sludge could be transported in segregated ballast tanks only, water depth might still be a limiting factor at some inner POLA/ POLB Harbor Complex docks during low tide, e.g. at LA 163-164 Chevron can only load bunker fuel at low tide (62).

Table 6-1 gives the water depths at the docks of Figure 3-1 above. It can be seen that the majority of the docks are water depth constrained. It should be noted that dredging at the POLA (to 60 feet of water depth) is planned beginning as early as 1978.

TABLE 6-1 WATER DEPTHS AT LA/OMA PROJECT AREA DOCKS[1/]

POLA/POLB HARBOR COMPLEX

Berth[2/]			Depth, Ft.	Berth[2/]			Depth, Ft.
A	37-40	Navy	35	K	181	DWP	34
B	45-47	Union	47	L	215	Gulf	35
C	70-71	Pennzoil	34	M	237-240	Mobil	35
D	97-102	Standard Cal.	32	N	73-74	Powerine	36
E	118-119	GATX	37	O	76-78	ARCO	40
F	120-121	Petrolane	35	P	84-87	Texaco	53
G	148-151	Union	36	Q	118-120	ARCO	57
H	163-164	Chevron	34	R	210-211	Exxon	40
I	167-169	Shell	35	S	201-202	Macmillan	60
J	171-173	Continental	34	T	Pier J	SOHIO	60
				U	89-90	Edison	37

OFFSHORE BERTHS [2/]

Berth #4	Standard of Calif., El Segundo	56 feet
	Gulf, Huntington Beach	43 feet

[1/] Water depth at Mean Lower Low (MLLW); Spread extreme of 7.9 feet.

[2/] See Figure 3-1 for berth locations,
Note: Water depth at Outer Harbor anchorage ranges from 45-71 feet, and water depths at breakwater gates are: Angel's (46 ft.) and Queen's (59 ft.).

INSTITUTIONAL CONSIDERATIONS

United States Coast Guard

In addition to the fact that the Hazardous Cargo and Materials Division of the Coast Guard would determine the safety classification of the sludge, the Coast Guard would further evaluate the following aspects of the project:

(1) The cumulative impact of the project on commercial and recreational vessel traffic, i.e. analyzed in conjunction with all other proposed projects.

(2) The adequacy of the backhaul alternative's spill prevention, control, and countermeasure elements, e.g. dockside boom deployment facilities.

(3) The chosen sludge dock locations, new or existing.

None of the aforementioned concerns would be considered by the Coast Guard as prohibitive to the exportation project, however the Coast Guard would review the project's specific construction and operations details, and might recommend mitigation measures that may affect the viability of the project, e.g. the Coast

Guard might determine that tank cleaning would be unacceptable at the docks.

Southern California Association of Governments

There are no specific planning/management policies of Section 208 of the federal Clean Water Act governing exportation (however, there are conditions of Section 208 governing the transport of wastewater effluent from one domestic regional basin to another) (63). In completing an A-95 review of the exportation alternative, staff members at SCAG have disclosed that they would be interested in knowing whether the LA/OMA Project Sanitation Agency(s) would be able to dissolve their sludge exportation contract(s), if a new, more cost-effective and innovative sludge management alternative came into being. Otherwise, SCAG's concerns reflect those of the Coast Guard, the Air Resources Board, and the Coastal Zone Commission, e.g. storage tanks and coastal esthetics.

California Coastal Zone Conservation Commission

The California Coastal Zone Conservation Commission would evaluate the sludge exportation project in accordance with the California Coastal Act of 1976. Chapter 3 and Chapter 8 of the Act contain those policies that appear to be most applicable to use by the planners of the Commission in their review of the exportation alternative. Article 7, Section 30261 of the Act, although aimed at "industrial development", basically reflects the concerns and the requirements of the Commission. The section reads as follows:

> Section 30261. (a) "Multi-company use of existing and new tanker facilities shall be encouraged to the maximum extent feasible and legally permissible, except where to do so would result in increased tanker operations and associated onshore development incompatible with the land use and environmental goals for the area. New tanker terminals outside of existing terminal areas shall be situated as to avoid risk to environmentally sensitive areas and shall use a monobuoy system, unless an alternative type of system can be shown to be environmentally preferrable for a specific site. Tanker facilities shall be designed to (1) minimize the total volume of oil spilled, (2) minimize the risk of collision from movement of other vessels, (3) have ready access to the most effective feasible containment and recovery equipment for oilspills, and, (4) have onshore deballasting facilities to receive any fouled ballast water from tankers where operationally or legally required."

It should be noted that the review of a "sludge dock" in the POLA or the POLB would be evaluated differently than an offshore sludge dock, i.e. the POLA/POLB dock(s) would be subject to an overall evaluation in the context of the port master plans (Coastal Act, Chapter 8) versus the offshore docks that would be subject to the provisions of Chapter 3 of the Act, e.g. recreational impact provisions.

Air Pollution Control Agencies

The Southern California Air Quality Management District (AQMD) would have the primary responsibility in the evaluation of the air quality impacts of an exportation project. Because of the magnitude of hydrocarbon emissions that would be emitted during tanker washing or sludge loading (64), a vapor recovery system would become a necessary facility (although there are no laws currently governing cargo-loading air pollution emission rates (as applied to tankers in California (65)). The installation of the VRS would necessitate the acquisition of an AQMD permit to allow for VRS construction. Furthermore, the cumulative total of the air pollution emissions from each element of the entire sludge exportation project would subject the project to a "new source review" (of the new air pollution emissions).

In explanation and by way of example, if the backhaul project was instituted at an existing petroleum dock, and if a VRS was assumed to be the only new element of the sludge exportation project, the oil company or one of the Agencies would apply to the AQMD for a "permit to construct" (it is anticipated that the oil companies might be required in the future to invest in VRS's if new laws are implemented governing the loading of refined products, e.g. gasoline, into tankers (66)). The VRS would most likely be considered (by the AQMD), according to the provisions of AQMD Rules 213 and 213.1, "New Source Review Rules" simply a modification to the existing facility (since no new emissions would result). Therefore, a permit to construct the VRS and/or a modification in the facility's existing air pollution permit (the existing "permit to operate") would be allowed. The permit and/or permit modifications would be granted, however, only if the VRS (as a dock modification) represented the "best available control technology".

If however, for a more complicated example, the Agency(s) decided to build their own "sludge dock", the air pollution emissions would again be the responsibility of the dock owner or leasee. Per Rule 213, if the hydrocarbon emissions after vapor recovery (emitting from the VRS itself) were greater than 25 pounds per hour, an air quality impact analysis would have to be completed by the Agency(s) and a 25 pound per hour or greater "air quality tradeoff" (based on Los Angeles air basin ambient air pollution concentrations rather than on source emissions) would have to be distinguished. It should be understood that the Agency(s) would not only be responsible for the VRS emissions, but would also be responsible for finding tradeoffs for all emissions from other anticipated project elements, including tanker stack emissions while "hoteling" at dock, storage tank emissions, pump emissions, and the emissions increase (although indirect) at the Los Angeles area power plant(s) supplying energy to the new dock. In other words, the project emissions would be totaled on a per-facility basis under Rule 213, and the leasee would be responsible for "everyone's" emissions. It should be noted that the differential air pollution emissions resulting from an alternative sludge management system, e.g. landfill sludge transport trucks, would not be considered viable offsetting air quality tradeoffs (67).

If the total, per-facility (new dock and infrastructure) emissions were less than 25 pounds per hour an air quality impact analysis would not be required. However, the project elements would be required to have best available control technology and/or be subject to other existing AQMD rules and regulations, e.g. the AQMD's "nuisance" rule (governing odors, etc.). Further, after a permit to construct was obtained, a subsequent permit to operate, if granted, may contain numerous conditions representing air pollution mitigation measures. Finally, separate new source review permits from the Federal Environmental Protection Agency would also be required (in accordance with CFR 52.333).

The above examples represent attempts to facilitate the reader's understanding of how current domestic air pollution law would affect a sludge exportation project. It would be advisible prior to any actions on the part of the Agency(s), that legal counsel should review Rule 213, and become aware of rulings that may be "handed down" on the emission's responsibility provisions of the Rule.

The Federal Department of Commerce

The Department of Commerce has no export control provisions (except to Communist countries)(68). Thus, with the exception of some concern pollution-free tanker operations (that would probably be expressed by the Maritime Affairs Division of DOC), the DOC may be expected to have little to say about the project. It is of great importance to acknowledge, however, that the Economic Development Administration of the DOC might promote and provide funds for the project if the project was found to be viable and acceptable (69).

The World Health Organization

Prior to sludge exportation implementation, the World Health Organization (WHO) would convene as an international group to disclose the varying reactions to the project. Basically, even if the WHO recognized sludge exportation as a viable alternative, i.e. to the nation(s) involved, the particular nation(s) would retain the perogative to decide whether to institute any new health regulations that might be deemed necessary. It should be noted that for reasons undisclosed but deemed "political", the exportation of solid waste has not been looked upon favorably by the inter-governmental organization (70).

The Petroleum Industry

The petroleum industry would have many dock availability and tanker chartering concerns if a backhaul alternative was seriously negotiated. Chapter's 7 and 8 disclose the primary elements necessary for backhaul operations as they relate to a cooperative program with the industry.

INTERIM CONCLUSIONS

The technical considerations might require extensive tanker retrofitting, and the institutional constraints may necessitate adequate mitigation measures, e.g. air pollution abatement equipment. However, assuming that a sludge need or disposal area could be found to justify economically beneficial sludge exportation while assuring acceptable sludge reuse management, it could be expected that the vessel operators would have necessary changes made, and that permitting agencies would grant required approvals. Therefore, without adding a variable of speculation that would represent little more than conjecture in the prediction of the impact the Alaskan oil upon tanker availability, the implementation of a backhaul (crude unloading/sludge loading) scheme can be investigated in terms of the 1976 data base available to this study.

CHAPTER 7

BACKHAUL ALTERNATIVE IMPLEMENTATION

DOCK AVAILABILITY

If it is assumed that any LA/OMA Project area dock could be considered as a candidate for a backhaul scheme, then it would be imperative for the chosen dock(s) to be situationally compatible to handle sludge, i.e. from an operational and locational standpoint. Obviously, some if not all of the docks could not be expected to cater to an increased number of tankers if the number of domestic and/or foreign tankers arriving precludes any additional tanker facilitation. Further, any additional tanker time at a dock necessary to load sludge, might result in one or more less-utilized docks to become marginal candidates for a backhaul scheme. This is a reasonable statement because the dock concern(s) would not want regular tanker scheduling to be constrained even if a backhaul agreement was profitable, i.e. if a crude oil tanker was delayed because of a "sludge spill" at the dock, the company's refinery might be temporarily excluded from service (likewise a power plant might not get necessary fuel oil). Finally, vessels "shifting" from other docks to the sludge dock(s) to load sludge, may cause an intolerable pattern of vessel movement in the POLA/POLB Harbor Complex, especially if the tankers that unloaded crude at El Segundo came to the Harbor Complex dock(s) to load sludge.

Therefore, it can be safely assumed that the dock concern would at least have a "first-use-of-the-dock" clause in any agreement made with the LA/OMA Project Sanitation Agency(s). As an overview, however, it should be noted that opinions differ substantially on dock utilization, especially at the POLA/POLB Harbor Complex, e.g. it has been disclosed that the Harbor Complex is vastly underutilized when compared to many other world ports(71).

Hence, notwithstanding that a significant volume of sludge might be loaded at a single dock, it becomes apparent from a tanker traffic standpoint, that it would be preferrable to load sludge at the three sub-regional locations, i.e. utilize the Huntington Beach and El Segundo offshore docks, and one or more docks within the Harbor Complex. These three locations, in the vicinities of the major LA/OMA Project areas wastewater treatment plants, would facilitate the implementation of the crude unloading/sludge loading scheme on a long-term basis, with the amount of tanker shifting and/or tanker "back-ups" minimized. It should be noted that because of the various dock availability constraints, the Harbor Complex sludge "dock" may have to be located at one of the anchorage areas within the breakwater. Likewise, if tank cleaning was deemed mandatory, the additional time necessary for cleaning plus the time for sludge loading may preclude the utilization of the existing docks offshore of El Segundo and Huntington Beach. Hence, new offshore docks would thus be anticipated to be necessary.

Implemented Backhaul Dock and Storage Locations

As characterized above, the existing docks may or may not be available for a backhaul scheme. Therefore, with regard to dock locations, the implementation of a backhaul operation would either involve the docks owned or leased by oil companies or new dock(s) owned or leased by LA/OMA Project Sanitation Agencies. For an existing dock, a "preferential assignment" would be given to the Agency(s) by the oil concern, meaning that if the Agency used the dock, they would simply pay ship and labor charges during the time the vessel was at dock, i.e. the Agency(s) would share the total dock lease "package".

It should be noted that since tanks necessary for sludge storage between vessel arrivals could be assumed to not be available at the LA/OMA Project Agency wastewater plants (72), new storage capacity and associated pumping and piping equipment must also be located on public and private property preferrably in direct proximity to the docks to minimize the time necessary for loading sludge.

It is not within the scope of this study to select based on "negotiations" with the dock concerns, the viable existing docks available for backhaul operations (if any). However, a cursory analysis (without regard to vessel frequency) of lease-area drawings and maps made available by the POLA and the POLB, suggests that land area might be available for tanks dockside or adjacent to LB 118-120, LB 201-202, LB 73-74, and LB 84-87 (the latter two constrained by water depth). Otherwise, vacant land on Terminal Island, e.g. one Mobil Oil "tank farm" area, the sewage treatment plant sludge drying "bed" area, or the land surrounding the Harbor Complex, might be available. Likewise, a review of maps commercially obtained from the El Segundo and Huntington Beach areas, suggests that land area for sludge storage might be available at or adjacent to Standard's refinery, or Gulf's tank farms, respectively. The potential for storage tank area near the future (proposed) docks of the Harbor Complex was not analyzed. Finally, it should be noted that field work questionnaire data suggested that petroleum tanks would not be available to store sludge.

In conclusion, it appears that Huntington Beach and El Segundo offshore dock locations could be used for backhaul operations (new or existing facilities). However, at the POLA/POLB Harbor Complex, a conveniently located existing dock is not readily apparent, i.e. many docks might have to be used, or the tankers may have to load sludge at anchor.

TANKER LOADING OF SLUDGE

Succinctly stated, new pumps could transfer the sludge from the wastewater treatment plants through new pipelines to new storage tanks, and then the sludge could be transferred by another set of pumps from storage into the tankers, i.e. in the same manner refineries transfer refined products for loading. Each tanker would already have a permanent manifold for sludge line hook-up however, new attaching manifolds on the ends of the sludge lines would be necessary. At the POLA/POLB Harbor Complex docks, these manifolds would probably represent the end attachments of "chicksan" counter-balanced loading/unloading arms permanently installed on the wharf. For the offshore berths, pipeline-end manifolds (plems) would likewise be necessary (attached to rubber hoses from the ocean bottom that connect the plems with the pipelines to shore). Finally, new "flushing" or displacement pipelines running alongside new submarine sludge loading pipelines would both be necessary if the oil companies could not use their existing pipelines to handle sludge. It should be noted that each oil company representative interviewed expressed doubt that the existing petroleum pipeline systems could be used to load sludge (especially in the case of sludge loaded simultaneously with cargo discharge).

It has been indicated that in most cases a ship would have to load sludge after all the imported cargo is discharged to assure proper tanker stability (73). The vessel frequency data and solicited opinions indicated that a vessel's average turnaround time in 1976 was approximately 3 days at the Harbor Complex, and approximately 2 days at the offshore berths (each included approximately 30 hours for discharge and 6 hours for ballast). Therefore, it might be safely assumed that sludge loading would involve another 2 days of tanker facilitation that would be jointly performed by the vessel crew and two or three dock workers who are responsible for line hook-up, cargo transfer, and safety precautions. Further, it would be reasonable to expect that one to three more days time would be necessary if tank cleaning was mandatory, for a total of three to five days after cargo discharge (74). The above time estimations were made notwithstanding the fact that the tankers can unload at high rates, e.g. 14,000 gallons per minute.

Finally, it should be noted that if a tanker had to make a shift to the "sludge " dock, he would first have to take-on seawater ballast such that the vessel could be easily guided by the tugs and pilots to the sludge dock. The amount of ballast necessary for this shift might exceed the physically segregated ballast capacity (averaging around 7-11% of the total cargo plus ballast capacity, excluding the tankers that are non-segregated). Therefore, sludge might have to be loaded into cargo tanks that contain seawater, because the discharge of dirty ballast prior to sludge loading is prohibited at the Harbor Complex.

APPLIED SAFETY

After carrying volatile cargoes, the displaced gas that would evolve (when sludge is loaded) is extremely dangerous and it is a fallacy, albeit a commonly-held one, to imagine that there is very little danger on board an oil tanker once the imported cargo has been discharged (75). Therefore, it would be preferrable if all the tankers that were loaded had inert gas systems to inert the tanks prior to washing and/or sludge loading. However, since most of the tankers from foreign countries in 1976 were documented to not have inert gas systems, it might be suggested that prior to any tank washing that blowers be used to remove hydrocarbon vapors from the tanks before washing begins. This is a common practice by many oil companies which would allow the vapor level to be reduced below the lower explosive limit. Concurrently, tank ventilation must be maintained during washing, and likewise, if segregated ballast tanks are used it may be necessary to continually ventilate such tanks during the sludge exportation voyage if a significant danger of explosion exists during the voyage. Further, a vacuum breaker might have to be installed on segregated ballast tanks to keep tanks from rupturing when loading sludge at temperatures as high as those of sludge from digestors (external pressure yields a partial tank vacuum (76)).

CHAPTER 8

TANKER CHARTERING, ECONOMICS, AND INSURANCE

TANKER CHARTERING AND SLUDGE HANDLING

The agreements for the use of the tankers herein analyzed were either voyage ("spot") charters, time charters, or bare boat charters. For a voyage charter contract, the ship owner receives a "rental" fee for the use of a tanker for one roundtrip voyage only, however the ship owner pays all expenses associated with the operation of the vessel, e.g. fuel costs. In contrast, a time charter contract (several voyages over a specified period of time) may be negotiated where the owner likewise receives rental compensation (based on the deadweight tonnage of the tanker), and pays all costs with the exception of vessel fuel, and port fees, i.e. dockage (per-day cost basis), wharfage (per-barrel cost basis), and tanker demurrage (per-day cost basis). Finally, for "bare boat" charters, a ship owner who does not want to worry with scheduling, crew hiring, and insurance associated with operating a tanker, will instead allow a concern (oil company) to operate the ship for a rental fee (that is typically more competitive than time and voyage charter rental fees)(77). A bare boat charter would mean, therefore, that the oil company would incur all the costs of tanker operation and be liable for the ship. Appendix D, gives typical time and voyage charter "forms" that would be completed for a voyage or a time charter. No "standard" form exists for bare boat charters, and the number of bare boat charters is negligible when compared to the number of voyage and time charters (78). The vessel compilation obtained from the logs of vessel activity that were made available, do not distinguish whether a ship was chartered (nevertheless, if a vessel's name includes the oil company's name, e.g. ARCO Independence, then it can be safely assumed that the ship was not chartered, but owned by ARCO). However, a review of the individual vessel frequencies suggests that the majority of the tankers were voyage-chartered in 1976. It has been disclosed that most oil companies prefer voyage chartering, i.e. unless they have had some prior experience with a particular ship and its crew, the oil companies prefer not to "lock" themselves into a particular ship and/or crew which they may not like (79). It should be noted that an oil company that has made a time-charter, e.g. of 5 years duration, cannot relinquish their contract with the charterer (unless through costly legal means and/or ramifications) (80).

Assuming that a scheme involving sludge backhauls could have been implemented in 1976, the LA/OMA Project Sanitation Agency(s) would have contacted the New York City broker(s) that would have made arrangements with the representative(s) of the ship owner/operator(s) that had had their tanker(s) voyaged-chartered to discharge at a LA/OMA Project area dock. However, the Agency(s) would have contacted the oil company(s)(some headquartered locally) if the tanker(s) had been owned by the oil company(s), or if the tanker(s) were already under time charter by the oil company(s).

Assuming an implemented backhaul scheme with the tankers documented to have returned to Indonesia in 1976 (Fleet 1 + 2), 99 of the 177 tankers that departed for Indonesia would have been chartered assuming they transported, at full cargo capacity the 1985 LA/OMA Project area sludge volume of 8.5 MGD or approximately 12,937,000 wet tons/year (in consideration of a cargo's specific density, the tanker capacities would be subject to no more than a ± 3% volume constraint (81). The above scenario reflects an implicit assumption (based on sludge generation) that 99 separate tankers would have been voyage-chartered in 1976. Therefore, one would think that the Agencies would have had to negotiate a large number of voyage charters. However, the few tankers that were assumed to be time-chartered did make as many as 7 round-trip voyages in 1976, e.g. the Sansinena with 6 departures in 1976 was time-chartered by Union Oil.

Thus, utilizing the available departure frequency data, 57 of the total of 94 departures (61%) from El Segundo to Indonesia in 1976 were found to have been made by an estimated total of 12 tankers that were time-chartered by Standard Oil of California, and 17 of the total of 83 departures (20%) from the POLA/POLB Harbor Complex to Indonesia in 1976, were made by approximately 4 tankers that were time-chartered by an assumed maximum of 4 different oil companies. This means then that a total of 16 tankers on time charters making 74 of the 99 departures (75%) could have theoretically been utilized for sludge transport (assuming the 16 tankers were of the average size of the 99 tankers).

Hence, for the sludge-transportation-to-Indonesia scenario that exploits the "status quo" of tanker operations in 1976, it might be inferred that the Agencies would have had to negotiate backhaul "codicils" prior to 1976 for an approximate minimum of 16 time-chartered tankers with an approximate maximum of 5 oil companies. In addition, it could be inferred that the Agencies would have had to negotiate at least 25 voyage charters during the year 1976. So, the number of voyage charters necessary to be made (for approximately 25 of 99 vessels) is not as large as one might have thought. Furthermore, since Standard of California at El Segundo time-chartered 12 of the 16 tankers assumed to be time-chartered in 1976, it is encouraging to note that the Agencies would not, in actuality, have had to negotiate 12 different time charters for the 12 tankers, but rather could have contracted only one "affreightment" charter(82). This type of agreement would have obligated Standard Oil to move a specified tonnage over a specified period of time using in 1976 not only the time-chartered ships, but also any voyage-chartered tankers necessary to assure that the sludge tonnage was transported to Indonesia. Therefore, assuming that all of the tankers that departed for Indonesia from El Segundo in 1976 (approximately 99 tankers, a few of which departed via the POLA/POLB Harbor Complex) could have been used to transport the sludge under one affreightment charter, it could be conceived that the Agencies would have negotiated only 1 contract for the year 1976 to handle the 1985 sludge volume.

Nevertheless, in terms of tanker operations documented for 1976, when one considers tanker availability, loading/unloading time, and preferable vessel frequency, it might be concluded that the Agencies would have had to negotiate many more charters than were inferred from the above scenarios, i.e. the Agencies would have competed with the oil industry on a continuous basis throughout the year for tankers. Finally, it should be noted that the affreightment contract(s) with any owner/operator would have been difficult to find, especially for backhauls, and that no single commercial concern owned the necessary 99 tankers in 1976 (83).

TANKER OPERATION ECONOMICS

Petroleum Industry Operation and Maintenance Costs

Freight and port costs essentially comprise the total cost of tanker operations. Prior to a time charter, an oil industry chartering manager would compute, based on his experience with tanker operation costs, the round trip costs expected by estimating 1) the tanker costs per DWT per month based on a number of tanker days at sea, and 2) the port costs of given ports. The manager would then compile the two estimates such that he could arrive at a total voyage cost and thus disclose the expected cost on a per ton basis by dividing the total voyage costs by the tons of cargo the oil company plans to import. The manager would then be in a better position to negotiate the costs of the time-charter in the "market place", however there is no absolute rate structure subject to governmental regulation in the world tanker transport industry market. Therefore, in the case of the tankers time-chartered to import oil from foreign countries in 1976, the manager would have made an agreement with an owner/operator to move the oil for some negotiated rate (with escalation clauses probably included in time charter).

With regard to spot charters, the chartering manager would have typically reviewed the "Worldscale" costs, compiled and periodically changed by The Association of Ship Brokers and Agents (Worldscale Inc., of New York City and London). These rates, based on vessel size, typically would not include port dockage and wharfage costs at both the loading and unloading ports. It should be noted, however, that the documented Worldscale freight rate, referred to as "Worldscale 100", is subject to the supply and demand of tankers, and is "intended solely as a standard of reference by means of which rates for all voyages and market levels can be compared and readily judged"(84). Therefore currently, the freight rate happens to be on the order of Worldscale 40, meaning 40% of the documented world scale (100%) rate. Likewise, demurrage rates (paid to the vessel operator ("to the ship") for the days(s) of vessel detention beyond the time allowed for loading, unloading, etc., i.e. typically, per charter, beyond 72 hours in port), are also documented by Worldscale, Inc., and vary proportionally to the freight rate.

Fortunately, time charter freight rates would also be related to the Worldscale freight and demurrage rates, and the components of the total voyage costs of spot and time-chartered tankers that have arrived at the LA/OMA Project area docks ("to Los Angeles") can be distinguished with relative accuracy. Table 8-1 given freight and port costs associated with tanker operations between Los Angeles and the three prevalent world regions distinguished above.

TABLE 8-1

COSTS OF TANKER OPERATION[1]
TO LOS ANGELES - PETROLEUM CARGOS

Freight[2] ($/long-ton cargo)	Loading Port[5]	Discharge Port Wharfage (¢/bbl)	 Dockage[3] ($/day)	Demurrage[4] ($/day)
		Port of Long Beach		
4.49	Dumai, Indonesia	(2¢/bbl)	(2,152)	7,480[6]
6.44	Kharg Island, Iran	(2¢/bbl)	(2,152)	6,560[7]
		Port of Los Angeles		
1.80	Esmeraldas,Ecuador	(2¢/bbl)	(2,152)	2,980[8]
		Offshore Dock		
		(5-10¢/bbl)[8]	(NONE)	

1/ For year 1977.
2/ Based on Worldscale 40, assumed for entire year.
3/ Based on a ship 800-850 ft. long.
4/ Demurrage rates typically are instituted for the time past 72 hours in port.
5/ Selected prevalent port; freight charges to LA may vary significantly from other ports of the same world region (function of distance).
6/ Based on 99,800 DWT vessel, at Worldscale 40.
7/ Based on 89,000 DWT vessel, at Worldscale 40.
8/ Based on 49,600 DWT vessel, at Worldscale 40.
9/ Based on estimated cost of a public concern utilizing a dock.

Source of Data: New York: Worldscale, Inc., & Poten & Partners;
Local: POLA & POLB Harbor Departments;
Southern California Edison

It should be noted that during the oil embargo of 1973, tanker freight rates as high as Worldscale 340 were evident in the world (85). The rate has since dropped drastically because the tanker tonnage has increased profoundly (larger ships built) since the embargo, and the current Worldscale 40 rate is evident because there is now a vast tanker "lay-up" (40,000,000 DWTs confined to dock because the owner/operator "continuation" rate (nearer to Worldscale 100) cannot be negotiated)(86).

Agency Backhaul Rate Negotiation Leverage

The freight rates of Table 8-1 above reflect round trip charges. Therefore, the "ship" has already been compensated for the ballast voyage back to the foreign nations (although it has been disclosed that some operators spend more than they are compensated (87)). As an example, a tanker that was voyage-chartered would leave Los Angeles (after discharge) compensated for the return voyage and neither the ship nor the oil company would have any remaining charter obligations to one another as soon as the tanker left the dock. Hence, a LA/OMA Project Sanitation Agency could be expected to have a reasonable "leverage" in negotiations for a backhaul sludge freight rate involving a backhaul tanker scheme, i.e. something less than Worldscale 40. It has been disclosed by a manager of a major oil company terminal in Los Angeles and by a maritime broker in New York City, that the backhaul freight rate would probably be on the order of $1.00/wet ton (including operator profit, but excluding port and demurrage expenses and depending entirely on what problems sludge handling entails)(88).

It should be noted at this point that a tanker returning with a full cargo of sludge might cost more than a tanker returning in ballast because the vessel might return at a slower speed, e.g. 11 knots rather than 12 knots, due to the larger load (Note: operators have speeds specified in either direction, and fuel consumption will not be a function of speed for small speed differentials (89)). Assuming that the return voyage with sludge did cost more, it would have been equal to approximately one day's "replacement cost" as a function time. In explanation, if it was assumed that a tanker operated between Indonesia (typically at 48 days sea time and 72 hours or 3 days port time (90), then the total voyage cost would have been calculated and divided by 51 days, e.g. an approximate replacement cost of $12,000/day for a Fleet 1 + 2 tanker of Figure 5-1 above. This cost/day would be considered the replacement cost, because the oil company may have to replace the petroleum tonnage now "delayed", and because of the potential for an increase in demand, the oil company may have to charter another tanker at Worldscale 50 (91).

Finally, the current port wharfage rates of Table 8-1 above for petroleum product loading and discharge would definitely be negotiable (for the Harbor Complex however, subject to California Port Authority approval (92)), and the demurrage rate would probably also be negotiable. However, the port dockage rates could be anticipated to be constant. Table 8-2 gives the potential leverage the Agencies might have with regard to a tanker backhaul operation to Indonesia.

TABLE 8-2 AGENCY BACKHAUL RATE NEGOTIATION LEVERAGE TO INDONESIA - SLUDGE CARGO

		Petroleum Discharge Port	
Freight ($/wt ton sludge)	Demurrage ($/day)	Wharfage (¢/bbl)	Dockage ($/day)
Less than 4.49 1/	Less than 7,480 1/	POLA/POLB Harbor Complex	
		(2/)	(3/)
		Offshore Docks	
		(4/)	(NONE)

1/ Subject to negotiations with ship owner/operator.
2/ Subject to POLA/POLB proposal to California Port Authority(s).
3/ Assumed to remain constant.
4/ Subject to negotiations with Standard of California and Gulf Oil
Note: 1) Some POLA/POLB docks/adjacent land are privately owned (not leased). Therefore, regular wharfage and/or dockage charges are not paid to the POLA/POLB.

MARINE INSURANCE

Policies are either time or voyage policies and they are also classified as valued or unvalued contracts. Most contracts are valued contracts, i.e. a value of a ship and/or cargo is agreed upon before the voyage. An unvalued contract would set the value of the ship and/or cargo following a loss (93).

It may be expected that for a backhaul charter, a tanker operator would have to acquire some type of additional insurance coverage for the ship, however the insurance associated with the sludge handling would basically be limited to insurance at the dock that has typically been in the form of both pollution insurance, e.g. spill-insurance and contingency funds, i.e. money that has been allocated in readily liquidable funds by the oil companies. It is expected that the Agencies would share in the insurance cost of a co-leased dock, however for a new sludge dock, a "spill contingency bond" might be necessary to complement insurance. It should be noted that the cost of spill clean-up from a ship is typically paid by the oil company that later passes the cost to the ship and its captain per charter. Figure 8-1 gives an idea of the frequency of tanker accidents that may involve insurance claims.

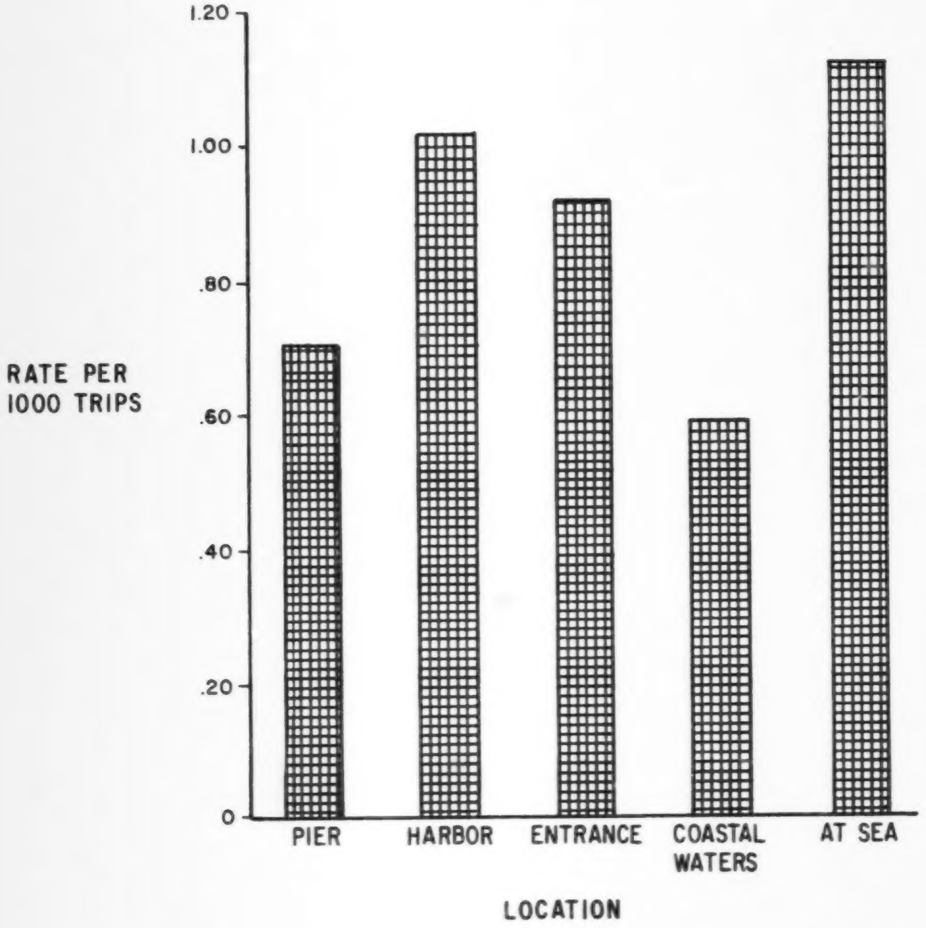


FIG. 8-1. TANKER ACCIDENT RATE PER LOCATION

Source: "Tanker Traffic Study", SOHIO West Coast to Mid-Continent Pipeline Project, Vol. 3, Part 3, Socio-Economic Systems, Inc., May, 1977.

CHAPTER 9

CAPITAL COST OF CO-USE AND SEPARATE FACILITIES

With consideration given to the various technical and institutional constraints that could be apparent in the implementation of backhaul operations, two permutations, P-1 and P-2, were developed to reflect potentially implementable backhaul operations based on 1976 tanker frequencies to Indonesia and 1985 sludge volumes. Each reflects the use of three sub-regional docks, however the permutations differ in one important respect -- it was assumed that if tank cleaning was mandatory, the Agencies would have to build their own docks. The cost permutations reflect the capital facilities of Figure 9-1, and they are basically a function of either privately- or publically-owned land. Table 9-1 distinguishes estimated capital costs for P-1, i.e. storage on Standard's and Gulf's property, co-use of offshore berths, and storage and co-use of existing docks at the Harbor Complex.

TABLE 9-1

SUB-REGIONAL CAPITAL COSTS[1]
BACKHAUL PERMUTATION #1

	Harbor Complex [2]	El Segundo [3]	Huntington Beach [3]
Pipelines & Pumps[4]	$ 4,900,000	$ 2,709,000	$ 3,489,000
Storage Tanks [5]	36,578,000	32,567,000	15,241,000
Dock Accessories [6]	9,310,000	7,810,000	7,810,000
	$50,788,000	$43,086,000	$26,540,000

P-1 Total: $120,414,000 or $19.00/dry ton sludge [7]

---

[1] Amortization: 6 3/8% for 20 years (assumed for useful and service life); New facilities were assumed to have no salvage value, and land costs were excluded.

[2] Co-lease of existing wharfside docks.

[3] Co-lease of existing offshore, spread mooring system; existing submarine pipelines assumed unavailable.

[4] Assumptions - Harbor Complex: 10 miles of 20" pipe and 2 pumping stations serving JWPCP and 2 docks. El Segundo: 2-mile onshore 16" submarine pipeline plus pumps and 7000' 8" displacement pipe. Huntington Beach: 4-mile onshore 16" pipeline to Gulf tank farm; 7000-foot 16" submarine pipeline plus pumps and displacement pipe.

[5] Sub-regional capacities (barrels) - Harbor Complex: (2,193,000); El Segundo (1,907,000); Huntington Beach (900,000). Capacities based on largest tanker capacity as a function of water depth, plus 12 days additional sludge contingency storage at each dock.

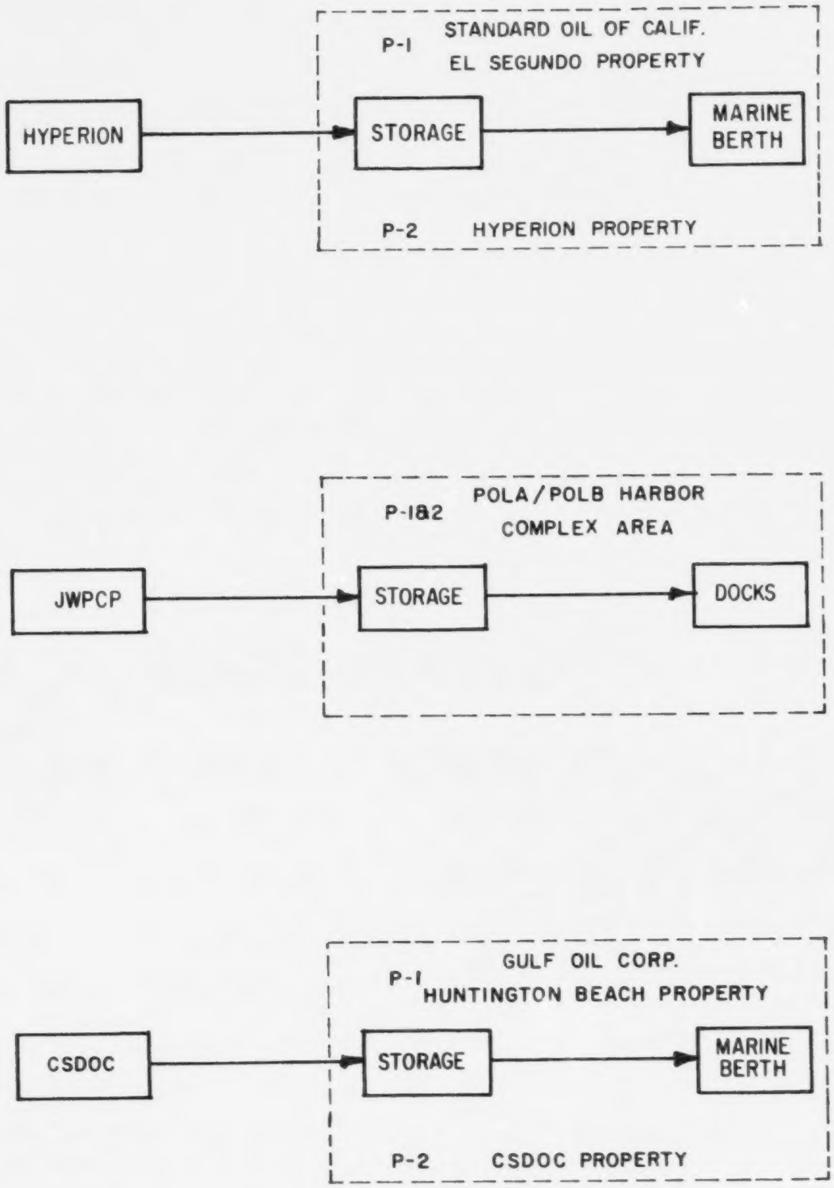


FIGURE 9-1. CAPITAL COST PERMUTATIONS

6/ Includes onshore and offshore manifolds plus VRS for each dock (each VRS assumed to be $7,310,000(94)).

7/ Expressed on 1985 raw sludge basis; 1977 pipe, pump and storage unit costs obtained from LA/OMA staff. Excludes wastewater treatment plant facilities, e.g. digestors and screens; also excludes tanker retrofit costs.

It can be seen from Table 9-1 that the capital cost of storage tanks are very high relative to the other facilities (70% of the total capital cost). Since this storage plus basically the same (other) facilities of P-1 would be necessary to determine the capital costs associated with P-2 (Agency-operated on Agency property), the cost of P-2 would be essentially equal to the cost of P-1 (pipelines would still be built to the oil companies to transfer recovered oil from oil-separated tank washings to be sold).

Tanker retrofit cost, if any, would be difficult to estimate, and it may be safely assumed that if an attractive backhaul freight rate was offered, that the tanker owner/operators might pay for their own retrofitting, e.g. external pump lubricating lines on tankers with cargo lubricating pumps might be retrofitted (or perhaps, the owner/operator might be, at least in part, subsidized by a new tax preference).

POTENTIAL REDUCTIONS IN CAPITAL COSTS

With this review of estimated capital costs, it should be understood that one or more things may reduce the capital costs of Table 8-3 and 8-4 above. These things include but are not limited to:

(1) Tanker availability/frequency might be assured, thereby reducing necessary storage capacity.

(2) The capital costs of the storage tanks might be shared by the oil company(s) and the Agency(s), i.e. oil companies are expected to be required by law to end operational ballast, inerting waste, and tank wash slop ocean discharges -- such liquids will have to be transferred to shore (96).

(3) The cost of the vapor recovery systems might be substantially reduced if displaced vapors could be burned by the ship boilers. Further, new VRS systems are expected to be required at oil company docks to collect vapor displaced by oil company tanker loading of refined products; thus, the VRS costs might be shared.

(4) Future and/or existing wastewater treatment plant digestor storage might provide some storage capacity and flow equalization, e.g. 6 days digestor capacity for a 30-day capacity digestor.

(5) The existing wastewater plant sludge ocean outfalls might be joined to the new spread mooring systems such that the Agency(s) would not have to install new offshore pipelines.

Hence, assuming a backhaul alternative was instituted beginning in 1985, it could be said that an unusual degree of capital cost flexibility might exist, especially if oil company/Agency mutual cooperation and facility co-use policies were apparent.

CHAPTER 10

INTEGRATED BACKHAUL SYSTEM COSTS

To estimate the total costs associated with the tanker sludge backhaul alternative including the associated supporting infrastructure, e.g. dock, pipeline, and storage costs, it was assumed that the tankers of Fleet 1 + 2 (of Figure 5-1) to Indonesia would be available for backhaul. As disclosed above, based on the anticipated 1985 sludge volume of 8.4 MGD, the cargo capacity of 99 of the 177 departing tankers (or a 56% "availability") would be needed to serve the three docks of capital cost permutation P-1 (co-lease of existing docks). Table 10-1 distinguishes the costs and underlying assumptions associated with the implementation of the backhaul alternative.

TABLE 10-1

ESTIMATED INDONESIAN-BACKHAUL ALTERNATIVE COSTS - AGENCY LEASED DOCKS

Tanker Operation Costs	
Backhaul Freight Rate	$20.00/dry ton sludge[1]
Wharfage for Harbor Complex[2]	$12,252/tanker
Wharfage for Offshore Docks[3]	$43,360/tanker
Dockage for Harbor Complex	$ 2,152/day
Vessel Demurrage Rate	$ 7,480/day
Harbor Complex Dock Labor	$ 1,440/tanker
Offshore Boat & Dock Labor	$ 2,920/tanker
Amortized Capital Costs	
Dock and Infrastructure Facilities	$10,787,000/year
Facilities Operation and Maintenance	
Dock and Infrastructure Facilities	$ 7.00/dry ton sludge

TOTALS ($/dry ton sludge)

Tanker Operation:[5]	31.00
Capital Costs:[6]	18.00
Facilities O & M:	7.00

Total Backhaul Alternative Costs: $56/dry ton sludge[7]

---

[1] Or $1.00/wet ton (2000 lbs) of sludge, assumed to Dumai, Indonesia, based on opinions from Poten & Partners (brokers, NYC), and ARCO marine terminal management. Assumes an average of 41% digester volatile solids destruction and 3% solids in digested sludge to be transported (LA/OMA Project data).

2/ Assumed @ 2¢/wet barrel, and based on 46 tankers/year at Fleet 1 average capacities.

3/ Assumed @ 5¢/wet barrel, and based on 53 tankers/year at Fleet 2 average capacities.

4/ Includes O & M for pipelines/pumps, storage tanks/pumps and VRSs.

5/ Incorporates 2 days demurrage, dockage, and labor costs, i.e. time for sludge loading at co-leased, existing docks.

6/ Refer to Table 9-1 for capital facilities and cost assumptions.

7/ Expressed in terms of 2000 raw sludge generation of 1685 dry tons/day (1977 price). Excludes all foreign capital and O & M costs.

It can be seen from Table 10-1 that tanker operation costs and capital facility costs dominate the total backhaul alternative cost to Indonesia. Thus, since these costs are constants, calculations would show that a backhaul operation involving Agency-owned docks would cost approximately the same (facilities O & M increases slightly for tank cleaning time, however recovered oil sales keep these O & M costs approximately constant).

The total costs of sludge exportation for the LA/OMA agencies were projected to be from $82 to $89/dry ton of raw sludge. Details of the cost calculations have been given in Table 2-2.

TANKER OPERATION COSTS TO OTHER NATIONS

If it is determined that a sludge need existed in a foreign nation that was not a "backhaul nation", the above Fleet 1 + 2 ships to Indonesia could be chartered to first go to the designated nation. The costs of such a re-route would be calculated based on the daily "replacement" cost the oil companies would incur, that is the cost of additional chartering such that the oil companies would meet their tonnage demand. For Fleet 1 + 2, this total replacement cost currently would be approximately $12-15,000/day per tanker. This cost represents a rate which reflects none of the negotiation leverage that would be evident in a backhaul operation. In essence, the cost would reflect the costs associated with chartering a ship dedicated to sludge transport, e.g. at Worldscale 40 and not the $1.00/wet ton estimate used for calculations in Table 10-1.

CHAPTER 11

AIR POLLUTION IMPACT/ENERGY DEMAND

The backhaul operation involving the co-lease of existing docks would result in the following air pollution emissions:

TABLE 11-1

BACKHAUL ALTERNATIVE OPERATIONAL AIR POLLUTION[1]

(lbs/day)

	Carbon Monoxide	Hydro-Carbons	Nitrogen Oxides	Particulates	Sulfur Dioxide
Emissions:	0.50	492	1221	99	1186

---

[1] Includes dock operation emissions from sludge loading and tanker hoteling (97); assumes VRSs 95% efficient. Also includes power plant emissions.

The specific emissions factors (in lbs/1000 gal of fuel oil consumption) used are given in Table 11-2.

TABLE 11-2

AIR EMISSION FACTORS

	Particulates	SO_x	CO	HC	NO_x
Tanker Hoteling	10	159 S	Neg	3.2	36.4
Power Plant[1]	8	159 S	0.04	5	105
Sludge Loading[2]					
Harbor Complex	-	-	-	26,260 lb/tanker	-
El Segundo	-	-	-	36,719 lb/tanker	-

---

[1] Local utility electrical generating facilities
[2] Displacement of vapors from empty tankers

Power plant and tanker fuel oil consumption associated with a backhaul operation is given in Table 11-3.

TABLE 11-3

TOTAL BACKHAUL OPERATION ENERGY USE

Electrical Use:	57,000,000 KWH/year (power plant)
Fuel Oil Use:	98,000 BBLS/year (power plant) 313,000 BBLS/year (tankers)

The power plant energy usage rates in Table 11-3 represent energy consumption anticipated for the operation of new docks by wastewater agencies. Of the 313,000 barrels/year tanker fuel oil requirement, about 179,000 barrels/year would be consumed by tankers in the process of loading sludge before beginning their backhauls. Assuming a small speed differential for tankers returning with a fuel load of sludge, no additional energy would be consumed on their backhaul voyages (if they all went to the same Indonesian port). However, assuming one extra day of voyage time, the incremental replacement tonnage fuel requirements would be approximately 1,350 barrels of fuel oil per tanker or an additional 134,000 barrels/year of fuel oil use for an implemented backhaul alternative to Indonesia.

CHAPTER 12

BACKHAUL ALTERNATIVES AND THE FUTURE

FUTURE SEGREGATED BALLAST CAPACITY

The Tanker and Vessel Safety Act of 1977 as proposed calls for ships arriving at domestic ports to have segregated ballast tanks. Assuming new and existing tankers were fitted with physically segregated tanks, the amount of segregated ballast capacity of most of the vessels documented in this report would triple. For Fleet 1 + 2 to the Indonesian region, this would mean that the fleet would then have around 5-6 MGD of capacity. However, given the above constraints, e.g. inadequate tank ventilation associated with segregated tanks, and more importantly, recognizing that segregated ballast may be mandated for the sole purpose of water pollution prevention from accidental and operational discharges, it may be concluded that anything besides "clean ballast" in the tanks would not be looked upon favorably by the various institutional concerns.

OCEAN DISPOSAL

It is obvious that sludge in a segregated ballast tank could be discharged at a designated open ocean area, or the sludge could be "dribbled-out" as the tanker makes its 8,500-mile voyage back to Indonesia, or along the way to another nation. Approximately 2.3 MGD of sludge could have been discharged by the 1976 tanker fleets documented above. It is reasonable to assume that the tankers could have even "diluted" the sludge by taking-on seawater into the tanks progressively with sludge discharge. The discharge would come from the bottom of the ship and utilizing existing ship discharge lines. Such discharges may be considered beneficial to the open ocean marine biota (98). It should be noted that the Coast Guard is basically only interested in assuming that "no sheen" (referring to oil) be visible on the waters within twelve miles of the coast. For example, under current law, clean ballast with an oil content that produces no visible traces of oil when discharged on the surface of calm water (commonly accepted as 15 ppm) can be discharged anywhere, and this also applies to cargo tanks that have been washed (99). To complement this regulation, the Intergovernmental Maritime Consultative Organization (IMCO) of the United Nations has established international ocean pollution law limiting instantaneous rate discharges to 60 litres of oil per nautical mile with the total oil discharged on a ballast voyage not to exceed 1/15,000 of the total cargo carried (100). It is not known whether these discharge limits based on surface concentrations would be applied to sludge; they would not seem appropriate since sludge would not be expected to leave a visible sheen. Finally, it should be noted that the Federal Fisheries Management and Conservation Act of 1976 would probably prohibit any sludge discharger within 200 miles of the coast.

In retrospect therefore, it might be said that a potential exists for sludge ocean disposal on tanker backhauls. However, in realization of the fact that only a portion of the region's sludge could be handled and that the segregated tanks may require ventilating equipment (as required by the Coast Guard on sludge barges operating from Chicago), the disposal idea might not be implementable. Assuming that tankers could do the job, it is conceivable though that a portion of the region's sludge (perhaps 6 MGD, or the sludge of one plant in 1985) could be disposed at sea for less than $10.00/ dry ton of sludge (including all operational, maintenance, and capital costs).

CARGO TANK OIL WASHING AND SLUDGE HANDLING

It is believed that by 1985 tankers will be washing tanks progressively with crude discharge using an oil wash (101). These washes which are already being performed, assure that the receiving dock gets a maximum discharge, i.e. the oil washes leave very little residue in the tanker. It may be found that sludge, loaded in oil-cleaned tanks, might therefore gain a negligible amount of oil, and regular butterworthing time could be avoided.

BARGES

Barges might be used to transfer sludge to tankers before the tankers depart. This barge/tanker operation might be the most satisfactory solution at the Harbor Complex where a central backhaul dock cannot be located. However, the idea is severely limited because 1) many barge transfers would be necessary to load one tanker, and 2) a tanker would most likely already have seawater, in many cargo and segregated tanks, which would probably mix with loaded sludge.

CHAPTER 13

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

It is concluded that sludge exportation is not a viable alternative for the management of all sludge of the LA/OMA Region Sanitation Agencies. This conclusion is based primarily on the fact that costs associated with tanker transport of sludge to the prevailing exporting nations could be expected to be exceedingly high. Further, the large volume of sludge would mandate the use of crude oil cargo tankage that would most likely necessitate time-intensive tank cleaning. It should be noted, however, that a limited opportunity involving individual wastewater agencies may arise if one or more independent tanker operators were to find incentives to transport the sludge overseas.

It is also concluded that it may be possible for tankers to be used as vehicles for sludge transport and dispersal in the open ocean. Specifically, the segregated ballast capacity of the tankers deporting Standard Oil of California at El Segundo might be used for the transport and dispersal of a part of the sludge of the adjacent Hyperion Sewage Treatment plant. It should be recognized, however, that this possibility is precluded by State and Federal regulations.

RECOMMENDATIONS

(1) Sludge Exportation

It is recommended that sludge exportation not be actively pursued. However, should markets for sludge become available in one or more foreign nations, the individual LA/OMA Sanitation Agencies can use the information in this report to help them determine whether sludge exportation would be desirable.

(2) Tanker Transport and Disposal of Sludge at Sea

It is recommended that tankers should be reviewed as backhaul vehicles for open ocean sludge disposal. The review should be limited to 1) the portential for an affreightment charter to be negotiated with Standard Oil of California, and 2) an analysis of the legal constraints, if any, that may be associated with sludge disposal at sea.

APPENDIX A

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

The assistance of the following individuals in the preparation of this report is acknowledged.

Mr. L. W. Schmillen - Manager of Chartering; ARCO
Mr. W. P. Chambers - Repair Supervisor; ARCO
Mr. J. Sullivan - Manager, Marine Terminal; ARCO
Mr. L. Aloisio - Marine Terminal; ARCO
Mr. J. Aspland - Gas Engineer; ARCO
Mr. W. P. Ivey - Marine Department; Standard Oil, Calif.
Mr. W. Hansen - Terminal Superintendant; Standard Oil, Calif.
Mr. J. Durkson - Head, Planning; Standard Oil, Calif.
Capt. V. Haselton - Port Superintendant; Standard Oil, Calif.
Mr. L. R. Ray - Environmental Specialist; Standard Oil, Calif.
Mr. J. W. DeVries - Director of Shipping; Gulf Oil Company
Mr. C. W. Gilmore - Manager; Gulf Oil Company
Mr. T. Sheehan - Supervisor, Marine Operations; Union Oil Co.
Capt. E. S. Davis - Marine Superintendant; Texaco, Inc.
Mr. E. Alber - Manager; Marine Exchange
Mr. G. Gutman - Operations Manager; Marine Exchange
Mr. R. Harrison - President; Poten & Partnrs, New York
Mr. L. Kenny - Broker; Poten & Partnrs, New York
Mr. H. H. Harnagel - Director of Port Operations; POLB
Mr. A. Zetterberg - Assistant Director of Port Operations; POLB
Mr. G. Gray - Assistant Traffic Manager; POLB
Dr. Donald Bright - Director of Commerce; POLB
Dr. Rob Ricklef - Environmental Specialist; POLB
Mr. Sam Miller - Chief Gas Engineer; POLB
Mr. L. R. Hill - Environmental Scientist; POLA
Mr. C. H. Erikson - General Manager; Hendy Intl. Company
Mr. C. Pollock - Head, Design; Todd Shipyards
Mr. P. Watson - Director, Shipping; So. Calif. Edison Co.
Mr. D. Sampsell - President, Ingram Barge Company
Mr. M. Morrisette - Maritime Engineer; U. S. Coast Guard
Capt. J. C. Ide - Commander; U. S. Coast Guard
Capt. A. Taub - Captain of the Port; U. S. Coast Guard
Mr. C. Oliver - Manager, Sales; Fluor Ocean Services
Mr. N. W. Wright - Consultant, Wright & Associates
Mr. A. Jacobsen - President; Jacobsen Pilot Service
Dr. A. Gram - President; Gram-Phillips Asso.
Mr. G. Nelson - Director, Wastewater Div. City of Los Angeles
Mr. M. A. Dadasovich - Planner; Coastal Zone Commission
Mr. P. D. Venturini - Energy Manager; Calif. Air Resources Board
Miss S. Mathias - Planner; SCAG
Mr. J. Nachthseim - Maritime Director; Federal Dept. of Commerce
Mr. D. Wit - Research Scientist; World Health Organization
Mr. Larry M. Harms - Engineer; Worthington Pump
Mr. Ed Wheless - Design Engineer, CSDLAC
Mr. T. S. Wyman - Manager, Maritime Relations, Chevron Shipping Company
Mr. R. L. Nensesian - Vice President, Poten & Partners, New York.

APPENDIX B

REFERENCES

REFERENCES

(1) "Sludge Management Alternatives", LA/OMA Project, May, 1976.

(2) "Phase II Report", CH2M Hill, Inc., LA/OMA Project, January, 1977.

(3) "Phase II Report", CH2M Hill, Inc., LA/OMA Project, January, 1977, Data extrapolated from Chapter 2.

(4) Marine Exchange, ARCO, Texaco, and Union personnel, personal communication, May, 1977.

(5) Marine Exchange, Personal Communication, April, 1977.

(6) Ivey, W.P., Standard Oil of California, personal communication, April, 1977.

(7) DeVries, J.W., Gulf Oil, personal communication, May, 1977.

(8) DeVries, J.W., (Gulf Oil) and Ivey, W.P. (Standard Oil), personal communication, April, 1977.

(9) Alber, A. Marine Exchange, Personal communication, May, 1977.

(10) "Phase II Report", CH2M Hill, Inc., LA/OMA Project, January, 1977.

(11) Lo, M.P., LA/OMA Project, Private transmittals, May 20, 1977, June 6, 1977, and Sept. 27, 1977.

(12) "Energy Supply and Demand Study", SOHIO West Coast to Mid-Continent Pipeline Project DEIR, Vol. 3, Part 1, POLB, CPUC, September, 1976.

(13) Ibid, of Summary.

(14) Ibid, of Summary

(15) Ibid, of Summary

(16) Tepper, T, Texaco refinery manager, Personal communication, June 6, 1977.

(17) Sheehan, T. (Union Oil) and Dayton, Tom (Mobil Oil), Personal communication, June 21, 1977.

(18) Gilmore, C.W., Gulf Oil Corporation, Personal communication, June 21, 1977.

(19) Durkson, J., Standard Oil of California, Personal communication, June 21, 1977.

(20) King, C. "Tanker Practice", Standford Maritime, Ltd., Cox & Wyman, 1976.

(21) Hick, T.G. and Edwards, T.W., "Pump Application Engineering", McGraw-Hill, 1971.

(22) King, Ci, "Tanker Practice", 1976.

(23) Eppich, J., CSDLAC, Personal communication, June, 1977.

(24) Timperley, S.E., Ingersoll-Rand Co., Personal communication, July 12, 1977.

(25) Harm, L.M., Worthington Pump Co., Personal communication, August, 1977.

(26) Timperley, S.E., Personal communication, July, 1977.

(27) Wheless, E., CSDLAC, Personal communication, July, 1977.

(28) Wheless, E., CSDLAC, Personal communication, July, 1977.

(29) Wheless, E., CSDLAC, Personal communication, July, 1977.

(30) Chambers, W.P., ARCO, Personal communication, June, 1977.

(31) "Shipboard Guide to Pollution-Free Operations", U.S. Dept. of Commerce, Dec. 1976.

(32) Lo, M.P., LA/OMA Project, Private memo, June 3, 1977.

(33) Moshiri, M. (JWPCP) and Malm, V. (Hyperion), Personal communication, June 10, 1977.

(34) Standard Oil refinery and lab personnel, personal communication, July, 1977.

(35) King, C. "Tanker Practice", 1976.

(36) Ibid, Tank Cleaning Chapter.

(37) Ibid, Tank Cleaning Chapter.

(38) "Shipboard Guide to Pollution-Free Operations", DOC, 1976.

(39) Chambers, W.P., ARCO, Personal communication, June, 1977.

(40) Chambers, W.P., ARCO, Personal communication, June, 1977.

(41) Chambers, W.P., Personal communication, June, 1977.

(42) Pollock, C., Todd Shipyards, Personal communication, June, 1977.

(43) Lariviere, L., Goulds Pumps, Personal communication, August 22, 1977.

(44) Harnagle, H.H., POLB, Personal communication, July, 1977.

(45) Chambers, W.P., Personal communication, June, 1977.

(46) Chambers, W.P., Personal communication, June, 1977.

(47) Davis, Capt. E.S., Texaco, Inc., Personal communication, July, 1977.

(48) Sampsell, D., Ingram Barge Co., Personal communication, June 7, 1977.

(49) Pollock, C., Todd Shipyards, Personal communication, June, 1977.

(50) Moshiri, M., JWPCP, Personal Communication, June 10, 1977.

(51) "The Inert Flue Gas System Operating Instructions", BP Tanker Company, LTD., July, 1971.

(52) Aspland, J. (ARCO), and Morrisette M. (Coast Guard), July/Aug. 1977.

(53) Sampsell, D., Ingram Bargo Co., Personal communication, July, 1977.

(54) Davis, Capt. E.S., Personal communication, July, 1977.

(55) Chambers, W.P., Personal communication, June, 1977.

(56) Grady, C.P.L., Purdue University, Personal communication, June, 1977.

(57) Morrisette, M., Personal communication, June, 1977.

(58) Price, Rear Admiral R.I. Eleventh Coast Guard District, Personal communication, August 12, 1977, and Davis, Capt. E.S. Texaco, Inc., August 22, 1977.

(59) Mesavage, C., "Tanker Lightering Emissions", released by the POLB for public review September, 1976.

(60) "Comparative Air Quality Study on Vapor Recovery Systems and Floating Roof Tanks for the Port of Long Beach/SOHIO Project, Meteorology" Research, Inc., August 17, 1976.

(61) DeVries, J.W., Personal communication, July, 1977.

(62) Hansen, W., Chevron, Personal communication, April, 1977.

(63) Mathias, L., SCAG, Personal communication, July, 1977.

(64) Mesavage, C., "Tanker Lightering Emissions", September, 1976.

(65) Venturni, P., CARB, Personal communication, August, 1977.

(66) Venturni, P., CARB, Personal communication, August, 1977.

(67) McQuire, T., CARB, Personal communication, August, 1977.

(68) Nachthseim, J., Federal Dept. of Commerce, personal communication, August 1977.

(69) Nachthseim, J., Personal communication, August 1977.

(70) Wit, D., WHO, Personal communication, August 1977.

(71) Jacobsen, H., Long Beach Pilots, Personal communication, August 1977.

(72) Haug, R.T., and Lo, M.P., LA/OMA Project, July 1977.

(73) Watson, P., Edison, Personal communication, July 1977.

(74) Alotsio, L., ARCO, Personal Communication, July 1977.

(75) King, C., "Tanker Practice", 1976.

(76) Harnagle, H., POLB, June 1977.

(77) Sheehan, T., Union Oil, Personal communication, July 1977.

(78) Schmillen, L.W., ARCO, Personal communication, August 1977.

(79) Sullivan, J., ARCO, Personal communication, August 1977.

(80) Schmillen, L. W., Personal communication, August 1977.

(81) Graham, G. G., Morris Guralnick, Associates, Inc., Personal communication, August 16, 1977.

(82) Schmillen, L. W., Personal communication, August 1977.

(83) Kenny, L., Poten & Partners, N.Y., Personal communication, August 1977.

(84) Issman, T., Worldscale, Inc., Personal communication, July 24, 1977.

(85) Marcus, H. S., "The Challenge of Deepwater Terminals", Lexington (1975).

(86) Schmillen, L. W., Personal communication, August 1977.

(87) Sullivan, J. ARCO, Personal communication, June 1977.

(88) Sullivan, J. ARCO, and Harrison, R. Poten & Partners, Personal communications, June 1977.

(89) Chambers, W. P., ARCO, Personal communication, July 1977.

(90) Davis, Capt. E. S. Personal communication, July 1977.

(91) Schmillen, L. W., Personal communication, August 1977.

(92) Gray, G., POLE, Personal communication, August 1977.

(93) Watts, E. H., "Transportation Engineering and Insurance SCULB, June 1976 Thesis.

(94) "Comparative Air Quality Study on Vapor Recovery Systems and Fleating Roof Tanks for the Port of Long Beach/SOHIO Project, Meteorology Research, Inc., August 17, 1976.

(95) Raksit, Sagar, LA/OMA Project, Personal communication, July 1977.

(96) Tanker and Vessel Safety Act of 1977 (S. 682), National Safety News Article, July 1977.

(97) Mesavage, C., "Tanker Lightering Emissions", Sept., 1976.

(98) Bascom, W., SCCWRP, August 10, 1977.

(99) Shipboard Guide to PollutionFree Operations", U.S. Dept. of Commerce, Dec., 1976.

(100) Ibid

(101) Sullivan, J., ARCO, Personal communication, August 1977.

APPENDIX C

U.S. COAST GUARD FORM 4355
CHARACTERISTICS OF LIQUID CHEMICALS PROPOSED FOR BULK WATER MOVEMENT

DEPARTMENT OF TRANSPORTATION
U.S. COAST GUARD
CG-4355 (Rev. 5-75)

CHARACTERISTICS OF LIQUID CHEMICALS PROPOSED FOR BULK WATER MOVEMENT

Form Approved Budget Bureau
No. 04-R3033

RETURN ORIGINAL TO:
COMMANDANT (MHM-3), U.S. COAST GUARD, WASHINGTON, D.C. 20590

Please indicate when information supplied on this form is proprietary. It will be treated confidentially by the Coast Guard.

NAME

1. CHEMICAL NAME (for mixtures see CHEMICAL PROPERTIES question 1.)

2. CHEMICAL FORMULA(s)

3. COMMON INDUSTRIAL NAME(s) and Trade Names

PRODUCTION

1. INDUSTRIAL METHODS OF PRODUCTION

2. USES

PHYSICAL PROPERTIES

1. Normal State and Color		8. Vapor pressure at	p.s.i.a. or mm Hg
		70°F	
		105°F	
2. State and Color during Transportation (if different from above)		115°F	
		130°F	
3. Transportation temperature (if other than ambient)		9. Specify viscosity (water equals 1) at 20°C	
4. Sp. G. of liquid at 20°C (water equals 1)		10. Coeff. of thermal expansion of liquid per °C	
5. Sp. G. of vapor at 20°C and 1 atm (air equals 1)		11. Solubility in water at 20 C, percent by wt.	
6. Boiling point or range		12. Latent heat of vaporization at 1 atm, BTU/lb.	
7. Freezing point or range		13. Molecular weight	

CHEMICAL PROPERTIES

1. If the product is impure or a mixture, supply composition information and amounts present.

2. Chemical Stability
   a. Can the product be polymerized or decomposed? Yes ☐ No ☐
   If "Yes," describe conditions and possible hazards.

   b. Does it require inhibition or stabilization for safe shipment? Yes ☐ No ☐
   If "Yes," supply the following information.
   (1) Name of inhibitor or stabilizer
   (2) Amount normally added
   (3) Duration of effectiveness

   c. Is the product capable of a hazardous self-oxidation which might cause an explosion or detonation? Yes ☐ No ☐
   If "Yes," explain below.

PREVIOUS EDITIONS ARE OBSOLETE

d. Are toxic vapors produced by high temperature or combustion of the material? Yes ☐ No ☐
Describe conditions and identify gases evolved and approximate amounts.

3. Chemical Reactivity

a. If the product can react dangerously (such as evolution of heat or gas) with other chemicals, specify the kinds of chemicals to avoid.

b. Should the vapor composition in the cargo tank be controlled (inerted or padded) to prevent such problems as peroxide formation, reaction with moisture, or unusual flammability hazards? Yes ☐ No ☐
If "Yes," briefly describe the problem and specify satisfactory inerting or padding materials and any necessary restrictions.

c. Is the product an oxidizing or reducing agent? Yes ☐ No ☐

d. Does the product decompose or react with air, water vapor, fresh water or salt water at a temperature below 115°F to produce toxic vapors, high temperature, or rapid evolution of gas? Yes ☐ No ☐
If "Yes," describe the nature and rate of reaction.

FLAMMABILITY

1. Flash point (Tag open cup, ASTM D1310)	°F
2. Flash point (Pensky-Martens closed cup, ASTM D93)	°F
3. Fire point (Cleveland open cup ASTM D92)	°F
4. Autoignition temperature (specify method)	°F
5. Reid vapor pressure (ASTM D323)	p.s.i.a. at 100°F
6. Flammable limits in air, % by volume (Indicate source such as National Fire Protection Association, Underwriters Laboratories, Company Laboratory, etc.)	

7. Suitable fire extinguishing agents
(In order of effectiveness)

MATERIALS OF CONSTRUCTION

1. If a dangerous reaction or significant corrosion is likely to occur when any of the materials listed below are used in a containment system transporting this product, indicate which materials are unsatisfactory and briefly describe the nature of the problem.

Mild Steel	Zinc
Stainless Steel	Tin
Aluminum	Brass
Copper	Bronze

2. Are any other common materials (coatings, linings, plastics, etc.) unsuitable for use with the product? Yes ☐ No ☐
If "Yes," explain below:

3. Are acetylene or acetylene-like impurities, which may react with copper, silver, or mercury to form unstable acetylides, present in the product? Yes ☐ No ☐

4. Effect on ordinary steel:	Type of Steel	Rate of corrosion at 100°F

5. Recommended materials of construction:

Use	Materials	Rate of corrosion at 100°F
Tanks		
Pipes		
Valves		

6. Describe any peculiarities of corrosion such as pitting, intergranular corrosion, aeration effects, etc., with the recommended materials of construction.

SKIN AND EYE CONTACT

1. Describe effects of contact with skin and eyes (such as blistering or destruction of tissue) and the duration of contact which will produce these effects. Is the product a primary irritant or corrosive liquid? Yes ☐ No ☐

TOXICITY

1. Acute Health Hazards
   a. Describe toxic effects from inhalation, ingestion, and skin absorption. State approximate quantities or concentrations which will produce symptoms and serious effects.

   b. If short term toxicity tests on laboratory animals have been performed, complete the sections below where information is available. Indicate data sources or supply copies of the laboratory reports.

LD_{50} (oral, rats)	Other values (specify)
LD_{50} (dermal, rabbits)	
LC_{50} (rats, 1 hour)	

2. Chronic Health Hazards
   a. Can repeated exposures result in cumulative toxic effect or sensitization? Yes ☐ No ☐
   Describe symptoms and state approximate quantities or concentrations and time exposed.

   b. Have any long term studies been performed on laboratory animals? Yes ☐ No ☐
   Summarize findings or attach copies of the reports.

3. Describe past experience relating to hazards of handling and transporting this material.

TOXICITY (Continued)

4. DESCRIBE ODOR AND TASTE

5. MINIMUM CONCENTRATION READILY DETECTIBLE
a. In air by odor (ppm)
b. In water by taste (mg/kg)

6. ANTIDOTES AND FIRST AID TREATMENT

7. EMERGENCY PROCEDURES FOR
a. Spills
b. Fires

AQUATIC TOXICITY AND WATER QUALITY CHARACTERISTICS

1. Describe toxic effects on marine life. If TLm values for this material are available, provide these below (a TLm is the concentration of a substance which, within the specified time (generally 96 hours), will kill 50% of the exposed group of test organisms).

2. If data are available on the water quality characteristics listed below, provide this information.
   a. Biodegradation
   b. Biochemical oxygen demand (BOD_5, LB/LB; also specify test concentration, acclimated or non-acclimated bacteria)
   c. Bioaccumulation (also indicate, when known, if tainting or similar effects occur)
   d. Chemical oxygen demand (COD, LB/LB)
   e. Recommended waste water treatment scheme such as gravity separation, biological, and activated carbon

DOT REGULATIONS

1. DOT CLASSIFICATION AND TYPES OF PACKAGES PERMITTED

CARGO HANDLING

1. TYPE OF VESSELS PROPOSED FOR WATER MOVEMENT
2. EXPECTED LOADING AND DISCHARGE POINTS
3. PROPOSED ROUTE OF VESSEL OR BARGE
4. METHOD USED FOR LOADING AND DISCHARGING LIQUID CARGO (State maximum air pressure, type of pump, etc.)
5. STATE PRECAUTIONS TO BE EMPLOYED IN HANDLING LIQUID CARGO (List special safety equipment for protection of personnel)
6. METHODS USED FOR GAS-FREEING AND CLEANING CARGO TANKS

REMARKS AND ADDITIONAL DATA

DATE

SIGNATURE AND TITLE

NAME AND ADDRESS OF FIRM OR ORGANIZATION

APPENDIX D

TYPICAL MARITIME INDUSTRY TIME AND VOYAGE CHARTER FORMS

Association of Ship Brokers
& Agents (U.S.A.), Inc.
October 1977

**CODE WORD FOR THIS
CHARTER PARTY:
ASBATANKVOY**

TANKER VOYAGE CHARTER PARTY

PREAMBLE

______________ ______________
Place Date

IT IS THIS DAY AGREED between ______________________________

chartered owner/owner (hereinafter called the "Owner") of the ______________________________

SS/MS ______________________________ (hereinafter called the "Vessel")

and ______________________________ (hereinafter called the "Charterer")

that the transportation herein provided for will be performed subject to the terms and conditions of this Charter Party, which includes this Preamble and Part I and Part II. In the event of a conflict, the provisions of Part I will prevail over those contained in Part II.

PART I

A. Description and Position of Vessel:

Deadweight: tons (2240 lbs.) Classed:

Loaded draft of Vessel on assigned summer freeboard ft. in. in salt water.

Capacity for cargo: tons (of 2240 lbs. each) % more or less, Vessel's option.

Coated: ☐ Yes ☐ No

Coiled: ☐ Yes ☐ No Last two cargoes:

Now: Expected Ready:

B. Laydays:

Commencing: Cancelling:

C. Loading Port(s):

Charterer's Option

D. Discharging Port(s):

Charterer's Option

E. Cargo:

Charterer's Option

F. Freight Rate: per ton (of 2240 lbs. each)

G. Freight Payable to: at

H. **Total Laytime in Running Hours:**

I. **Demurrage per day:**

J. **Commission of % is payable by Owner to**

on the actual amount of freight, when and as freight is paid.

K. The place of General Average and arbitration proceedings to be London/New York (strike out one).

L. Tovalop: Owner warrants vessel to be a member of TOVALOP scheme and will be so maintained throughout duration of this charter.

M. Special Provisions:

IN WITNESS WHEREOF, the parties have caused this Charter, consisting of a Preamble, Parts I and II, to be executed in duplicate as of the day and year first above written.

Witness the signature of:

By: ____________________

Witness the signature of:

By: ____________________

PART II

1. **WARRANTY–VOYAGE–CARGO.** The vessel, classed as specified in Part I hereof, and to be so maintained during the currency of this Charter, shall, with all convenient dispatch, proceed as ordered to Loading Port(s) named in accordance with Clause 4 hereof, or so near thereunto as she may safely get (always afloat), and being seaworthy, and having all pipes, pumps and heater coils in good working order, and being in every respect fitted for the voyage, so far as the foregoing conditions can be attained by the exercise of due diligence, perils of the sea and any other cause of whatsoever kind beyond the Owner's and/or Master's control excepted, shall load (always afloat) from the factors of the Charterer a full and complete cargo of petroleum and/or its products in bulk, not exceeding what she can reasonably stow and carry over and above her bunker fuel, consumable stores, boiler feed, culinary and drinking water, and complement and their effects (sufficient space to be left in the tanks to provide for the expansion of the cargo), and being so loaded shall forthwith proceed, as ordered on signing Bills of Lading, direct to the Discharging Port(s), or so near thereunto as she may safely get (always afloat), and deliver said cargo. If heating of the cargo is requested by the Charterer, the Owner shall exercise due diligence to maintain the temperatures requested.

2. **FREIGHT.** Freight shall be at the rate stipulated in Part I and shall be computed on intake quantity (except deadfreight as per Clause 3) as shown on the Inspector's Certificate of Inspection. Payment of freight shall be made by Charterer without discount upon delivery of cargo at destination, less any disbursements or advances made to the Master or Owner's agents at ports of loading and/or discharge and cost of insurance thereon. No deduction of freight shall be made for water and/or sediment contained in the cargo. The services of the Petroleum Inspector shall be arranged and paid for by the Charterer who shall furnish the Owner with a copy of the Inspector's Certificate.

3. **DEADFREIGHT.** Should the Charterer fail to supply a full cargo, the Vessel may, at the Master's option, and shall, upon request of the Charterer, proceed on her voyage, provided that the tanks in which cargo is loaded are sufficiently filled to put her in seaworthy condition. In that event, however, deadfreight shall be paid at the rate specified in Part I hereof on the difference between the intake quantity and the quantity the Vessel would have carried if loaded to her minimum permissible freeboard for the voyage.

4. **NAMING LOADING AND DISCHARGE PORTS.**

(a) The Charterer shall name the loading port or ports at least twenty-four (24) hours prior to the Vessel's readiness to sail from the last previous port of discharge, or from bunkering port for the voyage, or upon signing this Charter if the Vessel has already sailed. However, Charterer shall have the option of ordering the Vessel to the following destinations for wireless orders:

	On a voyage to a port or ports in
ST. KITTS	Carribbean or U.S. Gulf loading port(s)
PORT SAID	Eastern Mediterranean or Persian Gulf loading port(s) (from ports west of Port Said.)

(b) If lawful and consistent with Part I and with the Bills of Lading, the Charterer shall have the option of nominating a discharging port or ports by radio to the Master on or before the Vessel's arrival at or off the following places:

Place	*On a voyage to a port or ports in:*
LAND'S END	United Kingdom/Continent (Bordeaux/Hamburg range) or Scandinavia (including Denmark)
SUEZ	Mediterranean (from Persian Gulf)
GIBRALTER	Mediterranean (from Western Hemisphere).

(c) Any extra expense incurred in connection with any change in loading or discharging ports (so named) shall be paid for by the Charterer and any time thereby lost to the Vessel shall count as used laytime.

5. **LAYDAYS.** Laytime shall not commence before the date stipulated in Part I, except with the Charterer's sanction. Should the Vessel not be ready to load by 4:00 o'clock P.M. (local time) on the cancelling date stipulated in Part I, the Charterer shall have the option of cancelling this Charter by giving Owner notice of such cancellation within twenty-four (24) hours after such cancellation date, otherwise this Charter to remain in full force and effect.

6. **NOTICE OF READINESS.** Upon arrival at customary anchorage at each port of loading or discharge, the Master or his agent shall give the Charterer or his agent notice by letter, telegraph, wireless or telephone that the Vessel is ready to load or discharge cargo, berth or no berth, and laytime, as hereinafter provided, shall commence upon the expiration of six (6) hours after receipt of such notice, or upon the Vessel's arrival in berth (i.e., finished mooring when at a sealoading or discharging terminal and all fast when loading or discharging alongside a wharf), whichever first occurs. However, where delay is caused to Vessel getting into berth after giving notice of readiness for any reason over which Charterer has no control, such delay shall not count as used laytime.

7. **HOURS FOR LOADING AND DISCHARGING.** The number of running hours specified as laytime in Part I shall be permitted the Charterer as laytime for loading and discharging cargo; but any delay due to the Vessel's condition or breakdown or inability of the Vessel's facilities to load or discharge cargo within the time allowed shall not count as used laytime. If regulations of the Owner or port authorities prohibit loading or discharging of the cargo at night, time so lost shall not count as used laytime; if the Charterer, shipper or consignee prohibits loading or discharging at night, time so lost shall count as used laytime. Time consumed by the vessel in moving from loading or discharge port anchorage to her loading or discharge berth, discharging ballast water or slops, will not count as used laytime.

8. **DEMURRAGE.** Charterer shall pay demurrage per running hour and pro rata for a part thereof at the rate specified in Part I for all time that loading and discharging and used laytime as elsewhere herein provided exceeds the allowed laytime elsewhere herein specified. If, however, demurrage shall be incurred at ports of loading and/or discharge by reason of fire, explosion, storm or by a strike, lockout, stoppage or restraint of labor or by breakdown of machinery or equipment in or about the plant of the Charterer, supplier, shipper or consignee of the cargo, the rate of demurrage shall be reduced one-half of the amount stated in Part I per running hour or pro rata for part of an hour for demurrage so incurred. The Charterer shall not be liable for any demurrage for delay caused by strike, lockout, stoppage or restraint of labor for Master, officers and crew of the Vessel or tugboat or pilots.

9. **SAFE BERTHING SHIFTING.** The vessel shall load and discharge at any safe place or wharf, or alongside vessels or lighters reachable on her arrival, which shall be designated and procured by the Charterer, provided the Vessel can proceed thereto, lie at, and depart therefrom always safely afloat, any lighterage being at the expense, risk and peril of the Charterer. The Charterer shall have the right of shifting the Vessel at ports of loading and/or discharge from one safe berth to another on payment of all towage and pilotage shifting to next berth, charges for running lines on arrival at and leaving that berth, additional agency charges and expense, customs overtime and fees, and any other extra port charges or port expenses incurred by reason of using more than one berth. Time consumed on account of shifting shall count as used laytime except as otherwise provided in Clause 15.

10. **PUMPING IN AND OUT.** The cargo shall be pumped into the Vessel at the expense, risk and peril of the Charterer, and shall be pumped out of the Vessel at the expense of the Vessel, but at the risk and peril of the Vessel only so far as the Vessel's permanent hose connections, where delivery of the cargo shall be taken by the Charterer or its consignee. If required by Charterer, Vessel after discharging is to clear shore pipe lines of cargo by pumping water through them and time consumed for this purpose shall apply against allowed laytime. The Vessel shall supply her pumps and the necessary power for discharging in all ports, as well as necessary hands. However, should the Vessel be prevented from supplying such power by reason of regulations prohibiting fires on board, the Charterer or consignee shall supply, at its expense, all power necessary for discharging as well as loading, but the Owner shall pay for power supplied to the Vessel for other purposes. If cargo is loaded from lighters, the Vessel shall furnish steam at Charterer's expense for pumping cargo into the Vessel, if requested by the Charterer, providing the Vessel has facilities for generating steam and is permitted to have fires on board. All overtime of officers and crew incurred in loading and/ or discharging shall be for account of the Vessel.

11. **HOSES MOORING AT SEA TERMINALS.** Hoses for loading and discharging shall be furnished by the Charterer and shall be connected and disconnected by the Charterer, or, at the option of the Owner, by the Owner at the Charterer's risk and expense. Laytime shall continue until the hoses have been disconnected. When Vessel loads or discharges at a sea terminal, the Vessel shall be properly equipped at Owner's expense for loading or discharging at such place, including suitable ground tackle, mooring lines and equipment for handling submarine hoses.

12. **DUES–TAXES–WHARFAGE.** The Charterer shall pay all taxes, dues and other charges on the cargo, including but not limited to Customs overtime on the cargo, Venezuelan Habilitation Tax, C.I.M. Taxes at Le Havre and Portuguese Imposto de Comercio Maritime. The Charterer shall also pay all taxes on freight at loading or discharging ports and any unusual taxes, assessments and governmental charges which are not presently in effect but which may be imposed in the future on the Vessel or freight. The Owner shall pay all dues and other charges on the Vessel (whether or not such dues or charges are assessed on the basis of quantity of cargo), including but not limited to French droits de quai and Spanish derramas taxes. The Vessel shall be free of charges for the use of any wharf, dock, place or mooring facility arranged by the Charterer for the purpose of loading or discharging cargo; however, the Owner shall be responsible for charges for such berth when used solely for Vessel's purposes, such as awaiting Owner's orders, tank cleaning, repairs, etc. before, during or after loading or discharging.

13. (a). **CARGOES EXCLUDED VAPOR PRESSURE.** Cargo shall not be shipped which has a vapor pressure at one hundred degrees Fahrenheit (100°F.) in excess of thirteen and one-half pounds (13.5 lbs.) as determined by the current A.S.T.M. Method (Reid) D-323.

(b). **FLASH POINT.** Cargo having a flash point under one hundred and fifteen degrees Fahrenheit (115°F.) (closed cup) A.S.T.M. Method D-56 shall not be loaded from lighters but this clause shall not restrict the Charterer from loading or topping off Crude Oil from vessels or barges inside or outside the bar at any port or place where bar conditions exist.

14. (a). **ICE.** In case port of loading or discharge should be inaccessible owing to ice, the Vessel shall direct her course according to Master's judgment, notifying by telegraph or radio, if available, the Charterers, shipper or consignee, who is bound to telegraph or radio orders for another port, which is free from ice and where there are facilities for the loading or reception of the cargo in bulk. The whole of the time occupied from the time the Vessel is diverted by reason of the ice until her arrival at an ice-free port of loading or discharge, as the case may be, shall be paid for by the Charterer at the demurrage rate stipulated in Part I.

(b) If on account of ice the Master considers it dangerous to enter or remain at any loading or discharging place for fear of the Vessel being frozen in or damaged, the Master shall communicate by telegraph or radio, if available, with the Charterer, shipper or consignee of the cargo, who shall telegraph or radio him in reply, giving orders to proceed to another port as per Clause 14 (a) where there is no danger of ice and where there are the necessary facilities for the loading or reception of the cargo in bulk, or to remain at the original port at their risk, and in either case Charterer to pay for the time that the Vessel may be delayed, at the demurrage rate stipulated in Part I.

15. **TWO OR MORE PORTS COUNTING AS ONE.** To the extent that the freight rate standard of reference specified in Part I F hereof provides for special groupings or combinations of ports or terminals, any two or more ports or terminals within each such grouping or combination shall count as one port for purposes of calculating freight and demurrage only, subject to the following conditions:

(a) Charterer shall pay freight at the highest rate payable under Part I F hereof for a voyage between the loading and discharge ports used by Charterer.

(b) All charges normally incurred by reason of using more than one berth shall be for Charterer's account as provided in Clause 9 hereof.

(c) Time consumed shifting between the ports or terminals within the particular grouping or combination shall not count as used laytime.

(d) Time consumed shifting between berths within one of the ports or terminals of the particular grouping or combination shall count as used laytime.

16. **GENERAL CARGO.** The Charterer shall not be permitted to ship any packaged goods or non-liquid bulk cargo of any description; the cargo the Vessel is to load under this Charter is to consist only of liquid bulk cargo as specified in Clause 1.

17. (a). **QUARANTINE.** Should the Charterer send the Vessel to any port or place where a quarantine exists, any delay thereby caused to the Vessel shall count as used laytime; but should the quarantine not be declared until the Vessel is on passage to such port, the Charterer shall not be liable for any resulting delay.

(b) **FUMIGATION.** If the Vessel, prior to or after entering upon this Charter, has docked or docks at any wharf which is not rat-free or stegomyia-free, she shall, before proceeding to a rat-free or stegomyia-free wharf, be fumigated by the Owner at his expense, except that if the Charterer ordered the Vessel to an infected wharf the Charterer shall bear the expense of fumigation.

18. **CLEANING.** The Owner shall clean the tanks, pipes and pumps of the Vessel to the satisfaction of the Charterer's Inspector. The Vessel shall not be responsible for any admixture if more than one quality of oil is shipped, nor for leakage, contamination or deterioration in quality of the cargo unless the admixture, leakage, contamination or deterioration results from (a) unseaworthiness existing at the time of loading or at the inception of the voyage which was discoverable by the exercise of due diligence, or (b) error or fault of the servants of the Owner in the loading, care or discharge of the cargo.

19. **GENERAL EXCEPTIONS CLAUSE.** The Vessel, her Master and Owner shall not, unless otherwise in this Charter expressly provided, be responsible for any loss or damage, or delay or failure in performing hereunder, arising or resulting from:– any act, neglect, default or barratry of the Master, pilots, mariners or other servants of the Owner in the navigation or management of the Vessel; fire, unless caused by the personal design or neglect of the Owner; collision, stranding or peril, danger or accident of the sea or other navigable waters; saving or attempting to save life or property; wastage in weight or bulk, or any other loss or damage arising from inherent defect, quality or vice of the cargo; any ac or omission of the Charterer or Owner, shipper or consignee of the cargo, their agents o representatives; insufficiency of packing; insufficiency or inadequacy of marks, explosion, bursting of boilers, breakage of shafts, or any latent defect in hull, equipment or machinery unseaworthiness of the Vessel unless caused by want of due diligence on the part of th Owner to make the Vessel seaworthy or to have her properly manned, equipped and sur plied; or from any other cause of whatsoever kind arising without the actual fault or privit of the Owner. And neither the Vessel nor Master or Owner, nor the Charterer, shall, unles otherwise in this Charter expressly provided, be responsible for any loss or damage or delay or failure in performing hereunder, arising or resulting from:– Act of God; act of war; perils of the seas; act of public enemies, pirates or assailing thieves; arrest or restraint of princes, rulers or people; or seizure under legal process provided bond is promptly furnished to release the Vessel or cargo; strike or lockout or stoppage or restraint of labor from whatever cause, either partial or general; or riot or civil commotion.

20. **ISSUANCE AND TERMS OF BILLS OF LADING**

(a) The Master shall, upon request, sign Bills of Lading in the form appearing below for all cargo shipped but without prejudice to the rights of the Owner and Charterer under the terms of this Charter. The Master shall not be required to sign Bills of Lading for any port which, the Vessel cannot enter, remain at and leave in safety and always afloat nor for any blockaded port.

(b) The carriage of cargo under this Charter Party and under all Bills of Lading issued for the cargo shall be subject to the statutory provisions and other terms set forth or specified in sub-paragraphs (i) through (vii) of this clause and such terms shall be incorporated verbatim or be deemed incorporated by the reference in any such Bill of Lading. In such sub-paragraphs and in any Act referred to therein, the word "carrier" shall include the Owner and the Chartered Owner of the Vessel.

(i) **CLAUSE PARAMOUNT.** This Bill of Lading shall have effect subject to the provisions of the Carriage of Goods by Sea Acts of the United States, approved April 16, 1936, except that if this Bill of Lading is issued at a place where any other Act, ordinance or legislation gives statutory effect to the International Convention for the Unification o Certain Rules relating to Bills of Lading at Brussels, August 1924, then this Bill of Ladin shall have effect, subject to the provisions of such Act, ordinance or legislation. The applicable Act, ordinance or legislation (hereinafter called the "Act") shall be deemed to be incorporated herein and nothing herein contained shall be deemed a surrender by the Owner of any of its rights or immunities or an increase of any of its responsibilities or liabilities under the Act. If any term of this Bill of Lading be repugnant to the Act to any extent, such term shall be void to that extent but no further.

(ii) JASON CLAUSE. In the event of accident, danger, damage or disaster before or after the commencement of the voyage, resulting from any cause whatsoever, whether due to negligence or not, for which, or for the consequence of which, the Owner is not responsible, by statute, contract or otherwise, the cargo shippers, consignees or owners of the cargo shall contribute with the Owner in General Average to the payment of any sacrifices, losses or expenses of a General Average nature that may be made or incurred and shall pay salvage and special charges incurred in respect of the cargo. If a salving ship is owned or operated by the Owner, salvage shall be paid for as fully as if the said salving ship or ships belonged to strangers. Such deposit as the Owner or his agents may deem sufficient to cover the estimated contribution of the cargo and any salvage and special charges thereon shall, if required, be made by the cargo, shippers, consignees or owners of the cargo to the carrier before delivery.

(iii) GENERAL AVERAGE. General Average shall be adjusted, stated and settled according to York/Antwerp Rules 1950 and, as to matters not provided for by those rules according to the laws and usages at the port of New York or at the port of London whichever place is specified in Part I of this Charter. If a General Average statement is required, it shall be prepared at such port or place in the United States or United Kingdom whichever country is specified in Part I of this Charter, as may be selected by the Owner, unless otherwise mutually agreed, by an Adjuster appointed by the Owner and approved by the Charterer. Such Adjuster shall attend to the settlement and the collection of the General Average, subject to customary charges. General Average Agreements and/or security shall be furnished by Owner and/or Charterer, and/or Owner and/or Consignee of cargo, if requested. Any cash deposit being made as security to pay General Average and/or salvage shall be remitted to the Average Adjuster and shall be held by him at his risk in a special account in a duly authorized and licensed bank at the place where the General Average statement is prepared.

(iv) BOTH TO BLAME. If the Vessel comes into collision with another ship as a result of the negligence of the other ship and any act, neglect or default of the Master, mariner, pilot or the servants of the Owner in the navigation or in the management of the Vessel, the owners of the cargo carried hereunder shall indemnify the Owner against all loss or liability to the other or non-carrying ship or her owners in so far as such loss or liability represents loss of, or damage to, or any claim whatsoever of the owners of said cargo, paid or payable by the other or recovered by the other or non-carrying ship or her owners as part of their claim against the carrying ship or Owner. The foregoing provisions shall also apply where the owners, operators or those in charge of any ships or objects other than, or in addition to, the colliding ships or object are at fault in respect of a collision or contact.

(v) LIMITATION OF LIABILITY. Any provision of this Charter to the contrary notwithstanding, the Owner shall have the benefit of all limitations of, and exemptions from, liability accorded to the owner or chartered owner of vessels by any statute or rule of law for the time being in force.

(vi) WAR RISKS. (a) If any port of loading or of discharge named in this Charter Party or to which the Vessel may properly be ordered pursuant to the terms of the Bills of Lading be blockaded, or

(b) If owing to any war, hostilities, warlike operations, civil war, civil commotions, revolutions or the operation of international law (a) entry to any such port of loading or of discharge or the loading or discharge of cargo at any such port be considered by the Master or Owners in his or their discretion dangerous or prohibited or (b) it be considered by the Master or Owners in his or their discretion dangerous or impossible for the Vessel to reach any such port of loading or discharge – the Charterers shall have the right to order the cargo or such part of it as may be affected to be loaded or discharged at any other safe port of loading or of discharge within the range of loading or discharging ports respectively established under the provisions of the Charter Party (provided such other port is not blockaded or that entry thereto or loading or discharge of cargo thereat is not in the Master's or Owner's discretion dangerous or prohibited). If in respect of a port of discharge no orders be received from the Charterers within 48 hours after they or their agents have received from the Owners a request for the nomination of a substitute port, the Owners shall then be at liberty to discharge the cargo at any safe port which they or the Master may in their or his discretion decide on (whether within the range of discharging ports established under the provisions of the Charter Party or not) and such discharge shall be deemed to be due fulfillment of the contract or contracts of affreightment so far as cargo so discharged is concerned. In the event of the cargo being loaded or discharged at any such other port within the respective range of loading or discharging ports established under the provisions of the Charter Party, the Charter Party shall be read in respect of freight and all other conditions whatsoever as if the voyage performed were that originally designated. In the event, however, that the Vessel discharges the cargo at a port outside the range of discharging ports established under the provisions of the Charter Party, freight shall be paid as for the voyage originally designated and all extra expenses involved in reaching the actual port of discharge and or discharging the cargo thereat shall be paid by the Charterers or Cargo Owners. In the latter event the Owners shall have a lien on the cargo for all such extra expenses.

(c) The Vessel shall have liberty to comply with any directions or recommendations as to departure, arrival, routes, ports of call, stoppages, destinations, zones, waters, delivery or in any otherwise whatsoever given by the government of the nations under whose flag the Vessel sails or any other government or local authority including any de facto government or local authority or by any person or body acting or purporting to act as or with the authority of any such government or authority or by any committee or person having under the terms of the war risks insurance on the vessel the right to give any such directions or recommendations. If by reason of or in compliance with any such directions or recommendations, anything is done or is not done such shall not be deemed a deviation.

If by reason of or in compliance with any such direction or recommendation the Vessel does not proceed to the port or ports of discharge originally designated or to which she may have been ordered pursuant to the terms of the Bills of Lading, the Vessel may proceed to any safe port of discharge which the Master or Owners in his or their discretion may decide on and there discharge the cargo. Such discharge shall be deemed to be due fulfillment of the contract or contracts of affreightment and the Owners shall be entitled to freight as if discharge has been effected at the port or ports originally designated or to which the vessel may have been ordered pursuant to the terms of the Bills of Lading. All extra expenses involved in reaching and discharging the cargo at any such other port of discharge shall be paid by the Charterers and/or Cargo Owners and the Owners shall have a lien on the cargo for freight and all such expenses.

(vii) DEVIATION CLAUSE. The Vessel shall have liberty to call at any ports in any order, to sail with or without pilots, to tow or to be towed, to go to the assistance of vessels in distress, to deviate for the purpose of saving life or property or of landing any ill or injured person on board, and to call for fuel at any port or ports in or out of the regular course of the voyage. Any salvage shall be for the sole benefit of the Owner.

21. LIEN. The Owner shall have an absolute lien on the cargo for all freight, deadfreight, demurrage and costs, including attorney fees, of recovering the same, which lien shall continue after delivery of the cargo into the possession of the Charterer, or of the holders of any Bills of Lading covering the same or of any storageman.

22. AGENTS. The Owner shall appoint Vessel's agents at all ports.

23. BREACH. Damages for breach of this Charter shall include all provable damages, and all costs of suit and attorney fees incurred in any action hereunder.

24. ARBITRATION. Any and all differences and disputes of whatsoever nature arising out of this Charter shall be put to arbitration in the City of New York or in the City of London whichever place is specified in Part I of this charter pursuant to the laws relating to arbitration there in force, before a board of three persons, consisting of one arbitrator to be appointed by the Owner, one by the Charterer, and one by the two so chosen. The decision of any two of the three on any point or points shall be final. Either party hereto may call for such arbitration by service upon any officer of the other, wherever he may be found, of a written notice specifying the name and address of the arbitrator chosen by the first moving party and a brief description of the disputes or differences which such party desires to put to arbitration. If the other party shall not, by notice served upon an officer of the first moving party within twenty days of the service of such first notice, appoint its arbitrator to arbitrate the dispute or differences specified, then the first moving party shall have the right without further notice to appoint a second arbitrator, who shall be a disinterested person with precisely the same force and effect as if said second arbitrator has been appointed by the other party. In the event that the two arbitrators fail to appoint a third arbitrator within twenty days of the appointment of the second arbitrator, either arbitrator may apply to a Judge of any court of maritime jurisdiction in the city above-mentioned for the appointment of a third arbitrator, and the appointment of such arbitrator by such Judge on such application shall have precisely the same force and effect as if such arbitrator had been appointed by the two arbitrators. Until such time as the arbitrators finally close the hearings either party shall have the right by written notice served on the arbitrators and on an officer of the other party to specify further disputes or differences under this Charter for hearing and determination. Awards made in pursuance to this clause may include costs, including a reasonable allowance for attorney's fees, and judgement may be entered upon any award made hereunder in any Court having jurisdiction in the premises.

25. SUBLET. Charterer shall have the right to sublet the Vessel. However, Charterer shall always remain responsible for the fulfillment of this Charter in all its terms and conditions.

26. OIL POLLUTION CLAUSE. Owner agrees to participate in Charterer's program covering oil pollution avoidance. Such program prohibits discharge overboard of all oily water, oily ballast or oil in any form of a persistent nature, except under extreme circumstances whereby the safety of the vessel, cargo or life at sea would be imperiled.

Upon notice being given to the Owner that Oil Pollution Avoidance controls are required, the Owner will instruct the Master to retain on board the vessel all oily residues from consolidated tank washings, dirty ballast, etc., in one compartment, after separation of all possible water has taken place. All water separated to be discharged overboard.

If the Charterer requires that demulsifiers shall be used for the separation of oil/water, such demulsifiers shall be obtained by the Owner and paid for by Charterer.

The oil residues will be pumped ashore at the loading or discharging terminal, either as segregated oil, dirty ballast or co-mingled with cargo as it is possible for Charterers to arrange. If it is necessary to retain the residue on board co-mingled with or segregated from the cargo to be loaded, Charterers shall pay for any deadfreight so incurred.

Should it be determined that the residue is to be co-mingled or segregated on board, the Master shall arrange that the quantity of tank washings be measured in conjunction with cargo suppliers and a note of the quantity measured made in the vessel's ullage record.

The Charterer agrees to pay freight as per the terms of the Charter Party on any consolidated tank washings, dirty ballast, etc., retained on board under Charterer's instructions during the loaded portion of the voyage up to a maximum of 1% of the total deadweight of the vessel that could be legally carried for such voyage. Any extra expenses incurred by the vessel at loading or discharging port in pumping ashore oil residues shall be for Charterer's account, and extra time, if any, consumed for this operation shall count as used laytime.

BILL OF LADING

Shipped in apparent good order and condition by ______________________________

on board the ______________________________ Steamship / Motorship ______________________________

whereof ______________________________ is Master, at the port of ______________________________

____

____

____

____

to be delivered at the port of ______________________________

or so near thereto as the Vessel can safely get, always afloat, unto ______________________________

or order on payment of freight at the rate of ______________________________

This shipment is carried under and pursuant to the terms of the contract / charter dated New York/London ______________________________

between ______________________________ and ______________________________, as Charterer, and all the terms whatsoever of the said contract / charter except the rate and payment of freight specified therein apply to and govern the rights of the parties concerned in this shipment.

In witness whereof the Master has signed ______________________________ Bills of Lading of this tenor and date, one of which being accomplished, the others will be void.

Dated at ______________________________ this ______________ day of ______________

____
Master

Form No. 80-165 Printed and Sold by Una & Co., Division of Scott Printing Corp., 190 Baldwin Ave., Jersey City, N.J. 07306 — N.J. (201) 795-5400 / N.Y. (212) 344-2270
Toll Free (800) 631-3098

CODE WORD FOR THIS CHARTER PARTY
STB TIME

____
Vessel Name

TANKER TIME CHARTER PARTY 1

________________ Place __________ Date 2

IT IS THIS DAY MUTUALLY AGREED between ________________________________

____

as Owner/Chartered Owner (herein called "Owner") of the ________________________________

________________________________ (herein called "Vessel") and

____

(herein called "Charterer") that the Owner lets and the Charterer hires the use and services of the Vessel for the carriage of ________________________________, in bulk, and such other lawful merchandise as may be suitable for a vessel of her description, for the period and on the terms and conditions hereinafter set forth.

TERM

1. (a) The term of this Charter shall be for a period of about (hereinafter "Original Period") plus any extensions thereof as provided in (b) below. The Original Period shall commence at the time when the Vessel is placed at the Charterer's disposal as provided in Clause 5. The word "about" as used above shall mean "14 days more or less" and shall apply to the term of this Charter consisting of the Original Period plus any extensions as hereinafter provided.

EXTENSIONS

(b) Charterer shall have the option of extending the term of this Charter for a period of ________________________________ (hereinafter "Extended Period") by written notice to Owner at least 30 days previous to the expiration of the Original Period. The term of this Charter may be extended by Charterer also for periods (hereinafter "Off-Hire Extensions") of all or any part of the time the Vessel is off hire during the Original Period and/or Extended Period, if any, by giving written notice to Owner at least 30 days before the expiration of the Original Period or Extended Period, as the case may be, and, if Charterer so elects and gives a further written notice to Owner at least 30 days before the expiration of any such Off-Hire Extension, all or any part of the time the Vessel is off hire following the previous notice shall be added to the term of this Charter.

VESSEL PARTICULARS

2. The following are particulars and capacities of the Vessel and her equipment:

A. Cargo Carrying Capacity

I. Total cargo tank capacity when 100% full ________________ US Barrels

II. Weight of stores, etc., permanently deducted from cargo carrying capacity ________________ L.T.

III. a. Fresh water consumption per day ________________ L.T.

b. Capacity of evaporators per day ________________ L.T.

c. Quantity of fresh water deductible from cargo carrying capacity on a daily basis ________________ L.T.

IV. Estimated loss of cargo carrying capacity due to "sag" when fully loaded with light, medium, heavy cargo

Light ________________ L.T.

Medium ________________ L.T.

Heavy ________________ L.T.

V. The vessel can carry ________________ tons (of 2,240 lbs.) total deadweight (as certified by Classification Society) of cargo, bunkers, water, and stores on an assigned summer mean draft of ________ ft. ________ in. and an assigned freeboard of ________ ft. ________ in.

B. Other Tank Capacities

I. Total capacity of fuel tanks for propulsion ________________ US Barrels

II. Total capacity of fresh water tanks ________________ L.T.

III. Total capacity of segregated ballast tanks ________________ L.T.

C. Capacity of Pumps

I. Cargo Pumps

a. Number ________________

b. Make ________________

c. Type ________________

d. Design rated capacity of each pump in U.S. Barrels per hour and corresponding head in feet ________________ US Bbls/Hr.

________________ Feet/Head

II. Stripping Pumps

a. Number ________________

b. Design capacity of each pump in U.S. Barrels per hour for the guaranteed discharge head of ________________ US Bbls/Hr.

________________ Feet/Head

III. **Segregated Ballast Pumps**

a. Number ____________

b. Design capacity each pump ____________ US Bbls/Hr.

D. **Cargo Loading/Discharge Manifold**

The whole manifold is made of steel or comparable material and is strengthened and supported to avoid damage from loading and discharge equipment and to withstand a maximum load from any direction equivalent to the safe working load of the cargo hose lifting equipment.

I. a. Number of manifold connections ____________

b. Diameter of manifold connections ____________

c. Distance from centers of manifold connections ____________

d. Distance from manifold connections to ship's side ____________

e. Distance center of manifold connections to deck ____________

f. Distance bow/center of manifold ____________

g. Safe working load of cargo hose lifting equipment ____________ tons.

II. **Cargo Manifold Reducing Pieces**

Vessels from 16 to 60 MDWT are equipped with a sufficient number of cargo manifold reducing pieces of steel or a comparable material to permit presenting of flanges of 8", 10" and 12" (ASA) cargo hoses/arms at all manifold connections on one side of the vessel.

Vessels over 60 MDWT are equipped with a sufficient number of cargo manifold reducing pieces of steel or a comparable material to permit presenting of flanges of 10", 12" and 16" (ASA) cargo hose/arms at all manifold connections on one side of the vessel.

E. **Heating Coils**

I. Type of coils and material of which manufactured ____________

II. Ratio heating surface/volume

a. Center Tanks Ft.^{2}/40 Ft.^{3}

b. Wing Tanks Ft.^{2}/40 Ft.^{3}

F. **Cargo Loading/Performance**

Vessel can load homogeneous cargo at maximum rate of ____________ B/H.

G. **Vessel Particulars**

I. Length overall ____________ ft. ____________ In.

II. Fully loaded summer draft in salt water of a density of 1.025

____________ ft. ____________ inches on an assigned freeboard of ____________.

III. Fresh Water allowance ____________ In.

IV. Light ship draft Forward ____________ Ft. ____________ In.

Aft ____________ Ft. ____________ In.

Mean ____________ Ft. ____________ In.

V. Moulded Depth ____________

VI. Light ship freeboard ____________ Ft. ____________ In.

VII. TPI on light ship draft ____________

VIII. TPI on summer draft ____________

IX. Extreme beam ____________

X. Gross Reg. Tons ____________

XI. Net Reg. Tons ____________

XII. Suez Canal Tonnage ____________

XIII. Panama Canal Tonnage ____________

XIV. Flag of Registry ____________

XV. Call letters ____________

XVI. Classification Society ____________

XVII. Maximum bunkers aboard when vessel is placed at Charterer's disposal to be ____________.

XVIII. Owner shall provide Charterer with copies of the Vessel's plans upon Charterer's request therefor, provided, in the case of a newbuilding, that Owner need not provide same until such plans are available to him from the building yard.

XIX. Vessel is equipped with a fresh water evaporator which will be maintained in good operating condition. Owners warrant that this evaporator is capable of making sufficient fresh water to supply the vessel's needs.

XX. Owner warrants vessel is capable of heating cargo to 135°F. and of maintaining same throughout entire discharge. Should vessel fail to heat cargo in accordance with Charterer's instructions, Charterer shall have the option to:

a) Delay discharge of the cargo

b) Delay berthing of the Vessel

c) Discontinue discharge and remove vessel from berth until cargo is heated in accordance with Charterer's instructions.

All time lost to be considered as off-hire and for Owner's account. In addition, any expenses incurred in moving vessel from berth will be for Owner's account.

HIRE

3. (a) The Charterer shall pay hire for the use of the Vessel at the rate of ____________________ in ____________________ currency per ton (of 2,240 lbs.) on Vessel's deadweight as shown in Clause 2. A. per calendar month, payment to be made in advance monthly at ____________________ ____________________ by check without discount commencing with the date and hour the Vessel is placed at Charterer's disposal hereunder and continuing to the date and hour when the Vessel is released to Owner at the expiration of this Charter except as otherwise expressed in this Charter. Any hire paid in advance and not earned shall be returned to the Charterer at once. In no event will initial payment of hire be made until Charter Party is signed and Vessel placed at Charterer's disposal as herein provided.

DEDUCTIONS

(b) The Charterer shall be entitled to deduct from hire payments: (1) any disbursements for Owner's account and any advances to the Master or Owner's agents, including commissions thereon, (2) layup savings calculated in accordance with Clause 17, (3) any previous overpayments of hire including offhire and including any overpayments of hire concerning which a bona fide dispute may exist but in the latter event the Charterer shall furnish an adequate bank guarantee or other good and sufficient security on request of the Owner, (4) any Clause 8 and 9 claims, and (5) any other sums to which Charterer is entitled under this charter. The Charterer shall be entitled to 2½% commission on any sums advanced or disbursements made for the Owner's account. However, the Owner shall have the option of making advances to the Charterer or its designated agent for disbursements (provided such advances are deemed adequate and reasonable by the Charterer), and, in such event, no commissions shall be paid.

FINAL VOYAGE

(c) Should the Vessel be on her final voyage at the time a payment of hire becomes due, said payment shall be made for the time estimated by Charterer to be necessary to complete the voyage and effect release of the Vessel to Owner, less all deductions provided for in sub-paragraph (b) of this Clause which shall be estimated by Charterer if the actual amounts have not been received and also less the amount estimated by Charterer to become payable by the Owner for fuel and water on release as provided in Clause 19. (b). Upon redelivery any difference between the estimated and actual amounts shall be refunded to or paid by the Charterer as the case may require.

LOSS OF VESSEL

(d) Should the Vessel be lost or be missing and presumed lost, hire shall cease at the time of her loss or, if such time is unknown, at the time when the Vessel was last heard of. If the Vessel should become a constructive total loss, hire shall cease at the time of the casualty resulting in such loss. In either case, any hire paid in advance and not earned shall be returned to the Charterer. If the Vessel should be off hire or missing when a payment of hire would otherwise be due, such payment shall be postponed until the off-hire period ceases or the safety of the Vessel is ascertained, as the case may be.

REDUCTION IN HIRE

(e) If the Vessel shall not fulfill the Owner's Warranty or any other part of her description as warranted in Clause 4, Charterer shall be entitled without prejudice to a reduction in the hire to correct for the deficiency and to any other rights the Charterer may have.

DEFAULT

(f) In default of punctual and regular payment as herein specified, the Owner will notify ____ at ____________________ ____________________ whereupon the Charterer shall make payment of the amount due within ten (10) days of receipt of notification from the Owner, failing which the Owner will have the right to withdraw the Vessel from the service of the Charterer without prejudice to any claim the Owner may otherwise have against the Charterer under this Charter.

INCREMENT

(g) The rate of hire set forth in sub-paragraph (a) of this Clause includes an increment of $____________________ to cover in full any expenses for Charterer's account for extra victualling by the Master, telephone calls, radio messages, telegrams and cables and all overtime worked by the Vessel's officers and crew at Charterer's request.

(h) The rate of charter hire set forth in this Clause 3 is equivalent to $____________________ per hour.

WARRANTIES

4. Owner warrants that at the time the Vessel is placed at Charterer's disposal, the Vessel shall fulfill the descriptions, particulars and capabilities set forth in Clause 2 above, and shall be tight, staunch, and strong, in thoroughly efficient order and condition and in every way fit, manned, equipped, and supplied for the service contemplated, with holds, cargo tanks, pipelines, and valves clear, clean, and tight and with pumps, heating coils, and all other equipment in good working order. Such description, particulars, and capabilities of the Vessel shall be maintained by Owner throughout the period of the Vessel's service hereunder so far as possible by the exercise of due diligence.

HIRE

5. (a) The use and services of the Vessel shall be placed at the disposal of the Charterer at ____ (hereinafter "Port of Delivery") at such readily accessible dock, wharf, or other place as the Charterer may direct. Charter hire shall commence when the Vessel is at such dock, wharf, or place and in all respects ready to perform this Charter and ready for sea and written notice thereof has been given by the Master to the Charterer or its Agents at the Port of Delivery.

LAYDAYS

(b) Hire shall not commence before ____ ____, except with Charterer's consent, and the Vessel shall be placed at Charterer's disposal in accordance with the provisions hereof no later than ____________________ in default of which Charterer shall have the option to cancel this Charter declarable not later than the day of the Vessel's readiness. Cancellation by Charterer or acceptance of the use of the Vessel's services shall be without prejudice to any claims for damages Charterer may have for late tender of the Vessel's services.

USE OF VESSEL

(c) The whole reach and burthen of the Vessel (but not more than she can reasonably stow and safely carry) shall be at the Charterer's disposal, reserving proper and sufficient space for Vessel's Officers, Crew, Master's cabin, tackle, apparel, furniture, fuel, provisions, and stores.

TRADING LIMITS

6. (a) The Vessel may be employed in any part of the World trading between and at ports, places, berths, docks, anchorages, and submarine pipe-lines in such lawful trades as the Charterer or its agents may direct, subject to Institute Warranties and Clauses attached hereto but may be sent to ports and places on the North American Lakes, the St. Lawrence River and tributaries between May 15 and November 15 and through the Straits of Magellan and around Cape Horn and The Cape of Good Hope at any time of the year without payment of any extra premium. Notwithstanding the foregoing restrictions, the Vessel may be sent to Baltic Sea ports not North of Stockholm, and to Helsingfors and Abo, Finland, and other ports and places as set forth in the Institute Warranties and Clauses, provided, however, that Charterer shall reimburse Owner for any additional premia properly assessed by Vessel's underwriters and payable by Owner for breach of such trade warranties.

BERTHS

(b) The Vessel shall be loaded, discharged, or lightened, at any port, place, berth, dock, anchorage, or submarine line or alongside lighters or lightening vessels as Charterer may direct. Norwithstanding anything contained in this Clause or any other provisions of this Charter, Charterer shall not be deemed to warrant the safety of any port, berth, dock, anchorage, and/or submarine line and shall not be liable for any loss, damage, injury, or delay resulting from conditions at such ports, berths, docks, anchorages, and submarine lines not caused by Charterer's fault or neglect or which could have been avoided by the exercise of reasonable care on the part of the Master or Owner.

FUEL

(c) The Charterer shall accept and pay for all fuel in the Vessel's bunkers at the time the vessel is placed at Charterer's disposal not exceeding the maximum quantity stated in Clause 2 above. Any excess quantity shall be removed by the Owner at its expense before such time unless the Charterer elects to accept such excess at the price determined as hereinafter provided or at such other price as may be mutually agreed. Payment for such fuel shall be in accordance with The Esso International Contract Price List current for the date when and the port or place where the vessel is placed at Charterer's disposal under the Charter or the nearest port to which such list applies.

CARGO

7. The Charterer shall have the option of shipping any lawful dry cargo in bulk for which the Vessel and her tanks are suitable and any lawful merchandise in cases and/or cans and/or other packages in the Vessel's forehold, 'tween decks, and/or other suitable space available, subject, however, to the Master's approval as to kind and character, amount and stowage. All charges for dunnage, loading, stowing, and discharging so incurred shall be paid by the Charterer.

SPEED, FUEL AND PUMPING WARRANTIES

8. The Owner warrants that the Vessel is capable of maintaining and shall maintain throughout the period of this Charter Party on all sea passages from Seabuoy to Seabuoy a guaranteed average speed under all weather conditions of ________________ knots in a laden condition and ________________ knots in ballast (speed will be determined by taking the total miles at sea divided by the total hours at sea as shown in the log books excluding stops at sea and any sea passage covered by an off-hire calculation) on a guaranteed daily consumption of ________________ tons (of 2,240 lbs.) of Diesel/Bunker C/High Viscosity Fuel Oil maximum ________________ seconds Redwood No. 1 at 100 degrees F. for main engine, and ________________ tons (of 2,240 lbs.) of Diesel for auxiliaries for propulsion.

For each day that heat is applied to cargo the guaranteed daily consumption is ________________ bbls. of Diesel/Bunker C/High Viscosity Fuel Oil maximum ________________ seconds Redwood No. 1 at 100 degrees F. per tank day. For each hour that tank cleaning is required, the guaranteed consumption is ________________ bbls. of Diesel/Bunker C/High Viscosity Fuel Oil maximum ________________ seconds Redwood No. 1 at 100 degrees F. per machine hour.

The Charterer is entitled to the full capabilities of the Vessel and the Owner warrants that the Vessel is capable of discharging a cargo of petroleum at the following minimum rates:

Light petroleum (viscosity less than 320 SSU at 100° F.) ________________ bbls/hr

Medium petroleum (viscosity of 320 to 3200 SSU at 100° F.) ________________ bbls/hr

Heavy petroleum (viscosity above 3200 SSU at 100° F.) ________________ bbls/hr

or of maintaining a pressure of 100 PSI at ship's rail should the foregoing minimum rates not be met.

Charterer is to be compensated at $ ________________ per hour or pro rata for each part of an hour that Vessel takes in excess of the pumping rates as stipulated above. The owner understands and agrees that he will receive no credit or compensation if the Vessel is able to discharge at a rate greater than those specified above. Any delay to Vessel's discharge caused by shore conditions shall be taken into account in the assessment of pumping performance. Pumping performance shall be reviewed in accordance with Clause 9.

ADJUSTMENT OF HIRE

9. (a) The speed and consumption guaranteed by the Owner in Clause 8 will be reviewed by the Charterer after three calendar months counting from the time of delivery of the Vessel to the Charterer in accordance with this Charter Party and thereafter at the end of each three (3) calendar month period. If at the end of each twelve (12) calendar month period (or at any time during the term of this charter) it is found that the Vessel has failed to maintain as an average during the preceding twelve (12) calendar month period (or for any other twelve month period during the term of this Charter) the speed and/or consumption warranted, the Charterer shall be retroactively compensated in respect of such failings as follows:

(b) Speed – Payment to Charterer of $ ________________ per hour or pro rata for each part of an hour that Vessel steams in excess of the equivalent time Vessel would have taken at the guaranteed speed warranted in Clause 8 as calculated in accordance with Attachment 1 – "Performance Calculations".

(c) Consumption – the Owner to reimburse the Charterer for each ton of 2,240 lbs. or pro rata for part of a ton in excess of the guaranteed daily consumption for main engine and/or auxiliaries and/or heating and/or tank cleaning including any excess not borne by the Owner in accordance with the off hire clause of this Charter Party at the average price for the particular grade of oil as set forth in the then current Esso International Contract Price List at ________________ for the total period under review provided that Vessel's actual speed is in accordance with Clause 8. To the extent the Vessel's speed is less than that warranted, fuel consumption allowed will be determined in accordance with Attachment 1 – "Performance Calculations".

(d) The basis for determining the Vessel's performance in (a) and (b) above shall be the statistical data supplied by the Master in accordance with Clause 14. (b).

(e) Owner to have similar privileges under this Clause for receiving compensation as Charterers do should Vessel performance as concerns speed be in excess or consumption for propulsion be below the descriptions outlined herein.

(f) The Charterer shall provide Owner with an opportunity to review any claim submitted by Charterer under this Clause, and the Owner shall complete such review, and provide Charterer with the results thereof within 30 days from the date such claim was mailed by Charterer to Owner. Charterer may deduct from hire any amount to which it is entitled under this Clause after the expiration of 40 days from the date of Charterer's mailing of a claim relating thereto to Owner.

In the event of Charterer having a claim in respect of Vessel's performance during the final year or part of the Charter period and any extension thereof, the amount of such claim shall be withheld from hire in accordance with Charterer's estimate made about two months before the end of the Charter period and any necessary adjustment after the end of the Charter shall be made by the Owner to the Charterer or the Charterer to the Owner as the case may require.

LIENS

10. The Owner shall have a lien on all cargoes for all amounts due under this Charter, and the Charterer shall have a lien on the Vessel for all moneys paid in advance and not earned, all disbursements and advances for the Owner's account, for the value of any of Charterer's fuel used or accepted for Owner's account, for all amounts due to Charterer under Clause 9, and other provisions of this Charter and for any damages sustained by the Charterer as a result of breach of this Charter by the Owner.

OFF HIRE

11. (a) In the event of loss of time from breakdown of machinery, interference by authorities, collision, stranding, fire, or other accident or damage to the Vessel, not caused by the fault of the Charterer, preventing the working of the Vessel for more than twelve consecutive hours, or in the event of loss of time from deficiency of men or stores, breach of orders or neglect of duty by the Master, Officers, or Crew, or from deviation for the purpose of landing any injured or ill person on board other than any person who may be carried at Charterer's request, payment of hire shall cease for all time lost until the Vessel is again in an efficient state to resume her service and has regained a point of progress equivalent to that when the hire ceased hereunder; cost of fuel consumed while the Vessel is off hire hereunder, as well as all port charges, pilotages, and other expenses incurred during such period and consequent upon the putting in to any port or place other than to which the Vessel is bound, shall be borne by the Owner; but should the Vessel be driven into port or to anchorage by stress of weather or on account of accident to her cargo, such loss of time, shall be for Charterer's account. If upon the voyage the speed of the Vessel be reduced or her fuel consumption increased by breakdown, casualty, or inefficiency of Master, Officers, or Crew, so as to cause a delay of more than twenty-four hours in arriving at the Vessel's next port or an excess consumption of more than one day's fuel, hire for the time lost and cost of extra fuel consumed, if any, shall be borne by the Owner. Any delay by ice or time spent in quarantine shall be for Charterer's account, except delay in quarantine resulting from the Master, Officers, or Crew having communications with the shore at an infected port, where the Charterer has given the Master adequate written notice of infection, which shall be for Owner's account, as shall also be any loss of time through detention by authorities as a result of charges of smuggling or of other infraction of law by the Master, Officers, or Crew.

(b) If the periods of time lost for which hire does not cease to be payable under the foregoing provisions of this Clause because each such period or delay is not of more than twelve (12) hours duration exceed in the aggregate one hundred and forty-four (144) hours in any charter party year (and pro rata for part of a year), hire shall not be payable for the excess and any hire overpaid by the Charterer shall be repaid by the Owner.

(c) In the event of loss of time by detention of the Vessel by authorities at any place in consequence of legal proceeding against the Vessel or the Owner, payment of charter hire shall cease for all time so lost. Cost of fuel and water consumed as well as all additional port charges, pilotages, and other expenses incurred during the time so lost shall be borne by the Owner. If any such loss of time shall exceed thirty consecutive days, the Charterer shall have the option to cancel this Charter by written notice given to the Owner while the vessel remains so detained without prejudice to any other right Charterer may have in the premises.

DRYDOCKING

12. (a) Owner, at its expense, shall drydock, clean, and paint Vessel's bottom and make all overhaul and other necessary repairs at reasonable intervals not to exceed twenty-four (24) months for which purpose Charterer shall allow Vessel to proceed to an appropriate port. Owner shall be solely responsible therefor, and also for gasfreeing the Vessel, upon each occasion. All towing, pilotage, fuel, water and other expenses incurred while proceeding to and from and while in drydock, shall also be for Owner's account. Fuel used during such drydocking or repair as provided in this Clause or Clause 15 or in proceeding to or from the port of drydocking or repair, will be charged to Owner by Charterer at the price charged to Charterer by its bunker supplier at such port if bunkers are obtained there or at the next replenishment port.

(b) In case of drydocking pursuant to this Clause at a port where Vessel is to load, discharge or bunker, under Charterer's orders, hire shall be suspended from the time the Vessel received free pratique on arrival, if in ballast, or upon completion of discharge of cargo, if loaded, until Vessel is again ready for service. In case of drydocking at a port other than where Vessel loads, discharges, or bunkers, under Charterer's orders, the following time and bunkers shall be deducted from hire: total time and bunkers including repair port call for the actual voyage from last port of call under Charterer's orders to next port of call under Charterer's orders, less theoretical voyage time and bunkers for the direct voyage from said last port of call to said next port of call. Theoretical voyage will be calculated on the basis of the seabuoy to seabuoy distance at the warranted speed and consumption per Clause 8.

OWNER PROVIDES

13. The Owner shall provide and pay for all provisions, deck and engine room stores, galley and cabin stores, galley and crew fuel, insurance on the Vessel, wages of the Master, Officers, and Crew, all certificates and other requirements necessary to enable the Vessel to be employed throughout the trading limits herein provided, consular fees pertaining to the Master, Officers, and Crew, all fresh water used by the Vessel and all other expenses connected with the operation, maintenance, and navigation of the Vessel.

MASTER'S DUTIES

14. (a) The Master, although appointed by and in the employ of the Owner and subject to Owner's direction and control, shall observe the orders of Charterer in connection with Charterer's agencies, arrangements, and employment of the Vessel's services hereunder. Nothing in this Clause or elsewhere in this Charter shall be construed as creating a demise of the Vessel to Charterer nor as vesting Charterer with any control over the physical operation or navigation of the Vessel.

(b) The Master and the Engineers shall keep full and correct logs of the voyages, which are to be patent to the Charterer and its agents, and abstracts of which are to be mailed directly to the Charterer from each port of call.

(c) If the Charterer shall have reason to be dissatisfied with the conduct of the Master or Officers, the Owner shall, on receiving particulars of the complaint, investigate it and if necessary, make a change in the appointments.

FUEL, PORT CHARGES, ETC.

15. (a) The Charterer (except during any period when the Vessel is off hire) shall provide and pay for all fuel except for galley and Crew as provided in Clause 13. The Charterer shall also pay for all port charges, light dues, dock dues, Panama and other Canal dues, pilotage, consular fees, (except those pertaining to Master, Officers, and Crew), tugs necessary for assisting the Vessel in, about, and out of port for the purpose of carrying out this Charter, Charterer's agencies and commissions incurred for Charterer's account and crew expense incurred for connecting and disconnecting cargo hoses and arms. The Owner shall, however, reimburse the Charterer for any fuel used or any expenses incurred in making a general average sacrifice or expenditure, and for any fuel consumed during drydocking or repair of the Vessel.

TUGS AND PILOTS

(b) In engaging pilotage and tug assistance, Charterer is authorized by Owner to engage them on behalf of Owner on the usual terms and conditions for such services then prevailing at the ports or places where such services are engaged, including provisions there prevailing, if any, making pilots, tug captains, or other personnel of any tug the borrowed servants of the Owner.

(c) Neither the Charterer nor its agents nor any of its associated or affiliated companies, nor any of their agents or employees, shall be under any responsibility for any loss, damage, or liability arising from any negligence, incompetence, or incapacity of any pilot, tug captain, or other personnel of any tug, or arising from the terms of the contract of employment thereof or for any unseaworthiness or insufficiency of any tug or tugs, the services of which are arranged by Charterer on behalf of Owner, and Owner agrees to indemnify and hold Charterer, its agents, associated and affiliated companies and their employees harmless from and against any and all such consequences.

(d) Charterer shall have the option of using its own tugs or pilots, or tugs or pilots made available or employed by any associated or affiliated companies, to render towage or pilotage services to the Vessel. In this event, the terms and conditions relating to such services prevailing in the port where such services are rendered and applied by independent tugboat owners or pilots, shall be applicable, and Charterer, its associated or affiliated companies and their pilots shall be entitled to all exemptions from and limitations of liability, applicable to said independent tugboat owners or pilots and their published tariff terms and conditions.

ADDITIONAL EQUIPMENT

16. The Charterer, subject to the Owner's approval not to be unreasonably withheld, shall be at liberty to fit any additional pumps and/or gear for loading or discharging cargo it may require beyond that which is on board at the commencement of the Charter, and to make the necessary connections with steam or water pipes, such work to be done at its expense and time, and such pumps and/or gear so fitted to be considered its property, and the Charterer shall be at liberty to remove it at its expense and time during or at the expiry of this Charter; the Vessel to be left in her original condition to the Owner's satisfaction.

LAY-UP

17. The Charterer shall have the option of laying up the Vessel for all or any portion of the term of this Charter, in which case hire hereunder shall continue to be paid, but there shall be credited against such hire the whole amount which the Owner shall save (or reasonably should save) during such period of layup through reduction in expenses, less any extra expenses to which the Owner is put as a result of such layup.

Should the Charterer, having exercised the option granted hereunder, desire the Vessel again to be put into service, the Owner will, upon receipt of written notice from the Charterer to such effect, immediately take steps to restore the Vessel to service as promptly as possible. The option granted to the Charterer hereunder may be exercised one or more times during the currency of this Charter or any extension thereof.

REQUISITION

18. (a) In the event that title to the Vessel shall be requisitioned or seized by any government authority (or the Vessel shall be seized by any person or government under circumstances which are equivalent to requisition of title), this Charter shall terminate automatically as of the effective date of such requisition or seizure.

(b) In the event that the Vessel should be requisitioned for use or seized by any government authority on any basis not involving, or not equivalent to, requisition of title, she shall be off hire hereunder during the period of such requisition, and any hire or any other compensation paid in respect of such requisition shall be for Owner's account, provided, however, that if such requisition continues for a period in excess of 90 days, the Charterer shall have the option to terminate this Charter upon written notice to the Owner. Any periods of off-hire under this Clause shall be subject to the Charterer's option for off-hire extension set forth in Clause 1 (b) hereof.

REDELIVERY

19. (a) Unless the employment of the Vessel under this Charter shall previously have been terminated by loss of the Vessel or otherwise, the Charterer shall release the Vessel to the Owner's use, free of cargo, at the expiration of the term of this Charter stated in Clause 1 (including any extension thereof provided in said Clause or elsewhere in this Charter), at ______________ ____ (herein called "Port of Redelivery") and shall give written notice of the date and hour of such release. At the Charterer's option, the vessel may be released to the Owner with tanks in a clean or dirty condition.

(b) The Owner shall accept and pay for all fuel in the Vessel's bunkers when this Charter terminates. Payment for such fuel shall be made in accordance with the Esso International Inc. Contract Price List current for the date when and the port or place where the Vessel is redelivered by Charterer to Owners under this Charter, or the nearest port to which such list applies.

BILLS OF LADING

20. (a) Bills of Lading shall be signed by the Master as presented, the Master attending daily, if required, at the offices of the Charterer or its Agents. However, at Charterer's option, the Charterer or its Agents may sign Bills of Lading on behalf of the Master. All Bills of Lading shall be without prejudice to this Charter and the Charterer shall indemnify the Owner against all consequences or

liabilities which may arise from any inconsistency between this Charter and any bills of lading or other documents signed by the Charterer or its Agents or by the Master at their request or which may arise from an irregularity in papers supplied by the Charterer or its Agents.

(b) The carriage of cargo under this Charter Party and under all Bills of Lading issued for the cargo shall be subject to the statutory provisions and other terms set forth or specified in subparagraphs (i) through (vi) of this Clause and such terms shall be incorporated verbatim or be deemed incorporated by the reference in any such Bill of Lading. In such subparagraphs and in any Act referred to therein, the word "carrier" shall include the Owner and the Chartered Owner of the Vessel.

(i) *Clause Paramount.* This bill of lading shall have effect subject to the provisions of the Carriage of Goods by Sea Act of the United States, approved April 16, 1936, except that if this Bill of Lading is issued at a place where any other Act, ordinance, or legislation gives statutory effect to the International Convention for the Unification of Certain Rules relating to Bills of Lading at Brussels, August 1924, then this Bill of Lading shall have effect subject to the provisions of such Act, ordinance, or legislation. The applicable Act, ordinance, or legislation (hereinafter called "Act") shall be deemed to be incorporated herein and nothing herein contained shall be deemed a surrender by the Owner or Carrier of any of its rights or immunities or an increase of any of its responsibilities or liabilities under the Act. If any term of this Bill of Lading be repugnant to the Act to any extent, such term shall be void to that extent but no further.

(ii) *New Jason Clause.* In the event of accident, danger, damage, or disaster before or after the commencement of the voyage, resulting from any cause whatsoever, whether due to negligence or not, for which, or for the consequences of which, the Carrier is not responsible, by statute, contract or otherwise, the cargo shippers, consignees, or owners of the cargo shall contribute with the Carrier in General Average to the payment of any sacrifices, losses, or expenses of a General Average nature that may be made or incurred and shall pay salvage and special charges incurred in respect of the cargo. If a salving ship is owned or operated by the Carrier, salvage shall be paid for as fully as if the said salving ship or ships belonged to strangers. Such deposit as the Carrier or its Agents may deem sufficient to cover the estimated contribution of the cargo and any salvage and special charges thereon shall, if required, be made by the cargo, shippers, consignees or owners of the cargo to the Carrier before delivery.

(iii) *General Average.* General Average shall be adjusted, stated, and settled according to York/Antwerp Rules 1950, as amended, and, as to matters not provided for by those rules, according to the laws and usages at the Port of New York. If a General Average statement is required, it shall be prepared at such port by an Adjuster from the Port of New York appointed by the Carrier and approved by the Charterer of the Vessel. Such Adjuster shall attend to the settlement and the collection of the General Average, subject to customary charges. General Average Agreements and/or security shall be furnished by Carrier and/or Charterer of the Vessel, and/or Carrier and/or Consignee of cargo, if requested. Any cash deposit being made as security to pay General Average and/or salvage shall be remitted to the Average Adjuster and shall be held by him at his risk in a special account in a duly authorized and licensed bank at the place where the General Average statement is prepared.

(iv) *Both to Blame.* If the Vessel comes into collision with another ship as a result of the negligence of the other ship and any act, neglect or default of the Master, mariner, pilot, or the servants of the Carrier in the navigation or in the management of the Vessel, the owners of the cargo carried hereunder shall indemnify the Carrier against all loss or liability to the other or noncarrying ship or her owners in so far as such loss or liability represents loss of, or damage to, or any claim whatsoever of the owners of said cargo, paid or payable by the other or recovered by the other or noncarrying ship or her owners as part of their claim against the carrying ship or Carrier. The foregoing provisions shall also apply where the owners, operators, or those in charge of any ships or objects other than, or in addition to, the colliding ships or object are at fault in respect of a collision or contract.

(v) *Limitation of Liability.* Any provision of this Charter to the contrary notwithstanding, the Carrier shall have the benefit of all limitations of, and exemptions from, liability accorded to the Owner or Chartered Owner of vessels by any statute or rule of law for the time being.

(vi) *Deviation Clause.* The Vessel shall have liberty to sail with or without pilots, to tow or be towed, to go to the assistance of vessels in distress, to deviate for the purpose of saving life or property or of landing any ill or injured person on board, and to call for fuel at any port or ports in or out of the regular course of the voyage.

21. *War Risks.* (a) No contraband of war shall be shipped, but petroleum and/or its products shall not be deemed contraband of war for the purposes of this Clause. Vessel shall not, however, be required, without the consent of Owner, which shall not be unreasonably withheld, to enter any port or zone which is involved in a state of war, warlike operations, or hostilities, civil strife, insurrection or piracy whether there be a declaration of war or not, where it might reasonably be expected to be subject to capture, seizure or arrest, or to a hostile act by a belligerent power (the term "power" meaning any de jure or de facto authority or any other purported governmental organization maintaining naval, military, or air forces).

(b) For the purposes of this Clause it shall be unreasonable for Owner to withhold consent to any voyage, route, or port of loading or discharge if insurance against all risks defined in Article 21 (a) is then available commercially or under a Government program in respect of such voyage, route or port of loading or discharge. If such consent is given by Owner, Charterer will pay the provable additional cost of insuring Vessel against Hull war risks in an amount equal to the value under her ordinary hull policy but not exceeding __________________. In addition, Owner may purchase war risk insurance on ancillary risks such as loss of hire, freight disbursements, total loss, etc., if he carries such insurance for ordinary marine hazards. If such insurance is not obtainable commercially or through a Government program, Vessel shall not be required to enter or remain at any such port or zone.

(c) In the event of the existence of the conditions described in Article 21 (a) subsequent to the date of this Charter, or while vessel is on hire under this Charter, Charterer shall, in respect of voyages to any such port or zone assume the provable additional cost of wages and insurance properly incurred in connection with Master, Officers and Crew as a consequence of such war, warlike operations or hostilities.

EXCEPTIONS

22. (a) The Vessel, her Master and Owner shall not, unless otherwise in this Charter expressly provided, be responsible for any loss or damage to cargo arising or resulting from: any act, neglect, default or barratry of the Master, Pilots, mariners or other servants of the Owner in the navigation or management of the Vessel; fire, unless caused by the personal design or neglect of the Owner; collision, stranding, or peril, danger or accident of the sea or other navigable waters; or from explosion, bursting of boilers, breakage of shafts, or any latent defect in hull, equipment or machinery. And neither the Vessel, her Master or Owner, nor the Charterer, shall, unless otherwise in this Charter expressly provided, be responsible for any loss or damage or delay or failure in performing hereunder arising or resulting from: act of God; act of war; perils of the seas; act of public enemies, pirates or assailing thieves; arrest or restraint of princes, rulers or people, or seizure under legal process provided bond is promptly furnished to release the Vessel or cargo; strike or lockout or stoppage or restraint of labor from whatever cause, either partial or general; or riot or civil commotion.

NUMBER OF GRADES

(b) The Owner warrants the Vessel is constructed and equipped to carry ______________ grades of oil. If for any reason the Vessel, upon arrival at a loading port, is unable to load the required number of grades, the Charterer will do its utmost to provide a suitable cargo consistent with Vessel's capabilities. However, if this is not possible the Vessel is to proceed to the nearest repair port in ballast and will there repair all bulkhead leaks necessary, any time and expense being for Owner's account.

(c) The exceptions stated in subparagraph (a) of this Clause shall not affect the Owner's undertakings with respect to the condition, particulars and capabilities of the Vessel, or the provisions for payment and cessation of hire or the obligations of the Owner under Clause 20 in respect of the loading, handling, stowage, carriage, custody, care and discharge of cargo.

23. All salvage moneys earned by the Vessel shall be divided equally between the Owner and the Charterer after deducting Master's, Officers' and Crew's share, legal expenses, hire of Vessel during time lost, value of fuel consumed, repairs of damage, if any, and any other extraordinary loss or expense sustained as a result of the service, which shall always be a first charge on such money.

24. Owner warrants that the Vessel is entered in TOVALOP and will remain so entered during the currency of this Charter, provided, however, that if Owner acquires the right to withdraw from TOVALOP under Clause VIII thereof, nothing herein shall prevent it from exercising that right.

OIL POLLUTION

When an escape or discharge of oil occurs from the Vessel and threatens to cause pollution damage to coastlines, Charterer may, at its option, and upon notice to Owner or Master, undertake such measures as are reasonably necessary to prevent or mitigate such damage, unless Owner promptly undertakes same. Charterer shall keep Owner advised of the nature of the measures intended to be taken by it. Any of the aforementioned measures actually taken by Charterer shall be at Owner's expense (except to the extent that such escape or discharge was caused or contributed to by Charterer), provided that if Owner considers said measures should be discontinued, Owner may so notify Charterer and thereafter Charterer shall have no right to continue said measures under the provisions of this Clause and all further liability to Charterer thereunder shall thereupon cease.

If any dispute shall arise between Owner and Charterer as to the reasonableness of the measures undertaken and/or the expenditure incurred by Charterer hereunder, such dispute shall be referred to arbitration as herein provided.

The provisions of this Clause are not in derogation of such other rights as Charterer or Owner may have under this Charter, or may otherwise have or acquire by law or any International Convention.

CLEAN SEAS

25. The Owner agrees to participate in the Charterer's program covering oil pollution avoidance. Such program aims to prevent the discharge into the sea anywhere in the world of all oil, oil water or ballast, chemicals or oily waste material in any form if the said material is of a persistent nature, except under extreme circumstances whereby the safety of the Vessel, cargo or life would be imperiled.

The Owner agrees to adhere to the oil pollution avoidance instructions provided by the Charterer in the Charterer's Vessel Instruction Manual together with any amendments which may be issued in writing or by radio to cover special cases or changes in International and National Regulations or Laws. The Master will contain on board the Vessel all oily residues from consolidated tank washings, dirty ballast, etc. Such residues shall be contained in one compartment after the separation of all possible water has taken place by safe methods employing the use of settlement and decanting or mechanic separation to approved and recognized standards.

The oily residue will be pumped ashore at the loading or discharge terminal either as segregated oil, dirty ballast, commingling with cargo or as is possible for Charterer to arrange with each cargo.

If the Charterer requires that demulsifiers be used for the separation of oil and water, the cost of such demulsifiers will be at the Charterer's expense.

Owner will also arrange for the Vessel to adhere to Charterer's oil pollution program during off-hire periods within the term of this Charter including the preparing of cargo tanks for drydocking and repairs. In the latter case, the Charterer agrees to bear costs for the disposal of oil residues.

Vessel will take all necessary precautions while loading and discharging cargo or bunkers as well as ballast to ensure that no oil will escape overboard.

Nothing in the Charterer's instructions shall be construed as permission to pollute the sea by the discharge of oil or oily water etc. The Owner agrees to instruct the Master to furnish Charterer with a report covering oil pollution avoidance together with details of the quantity of oil residue on board on arrival at the loading port.

PRODUCTS

26. Owner hereby agrees to receive sales representatives of affiliates of Charterer which market marine products. However, Owner is under no obligation to purchase from said affiliates, and said affiliates are under no obligation to sell to Owner any of such products. Owner designates the following as the appropriate persons or organizations with whom said affiliates should deal:

Name ____

Address ____

CHANGE OF OWNERSHIP

27. Owner's rights and obligations under this Charter are not transferable by Sale or Assignment without Charterer's consent. In the event of the Vessel being sold without its consent in addition to its other rights, Charterer may, at its absolute discretion, terminate the Charter, whereupon the Owner shall reimburse Charterer for any hire paid in advance and not earned, the cost of bunkers, for any sums to which Charterer is entitled under this Charter, and for any damages which Charterer may sustain.

ARBITRATION

28. Any and all differences and disputes of whatsoever nature arising out of this Charter shall be put to arbitration in the City of New York pursuant to the laws relating to arbitration there in force, before a board of three persons, consisting of one arbitrator to be appointed by the Owner, one by the Charterer, and one by the two so chosen. The decision of any two of the three on any point or points shall be final. Until such time as the arbitrators finally close the hearings either party shall have the right by written notice served on the arbitrators and on an officer of the other party to specify further disputes or differences under this Charter for hearing and determination. The arbitrators may grant any relief which they, or a majority of them, deem just and equitable and within the scope of the agreement of the parties, including, but not limited to, specific performance. Awards pursuant to this Clause may include costs, including a reasonable allowance for attorney's fees, and judgment may be entered upon any award made hereunder in any Court having jurisdiction in the premises.

ASSIGNMENT SUBLET

29. (a) Charterer, upon notice to Owner, may assign this Charter Party to any of its affiliates.

(b) Charterer shall also have the right to sublet the Vessel, but in the event of a sublet, Charterer shall always remain responsible for the fulfillment of this Charter in all its terms and conditions.

LAWS

30. The interpretation of the Charter and of the rights and obligations of the parties shall be governed by the laws applicable to Charter Parties made in the City of New York. The headings of Clauses are for convenience of reference only and shall not affect the interpretation of this Charter. No modification, waiver or discharge of any term of this Charter shall be valid unless in writing and signed by the party to be charged therewith.

IN WITNESS, WHEREOF, THE PARTIES HAVE CAUSED THIS CHARTER TO BE EXECUTED IN DUPLICATE THE DAY AND YEAR HEREIN FIRST ABOVE WRITTEN.

____________________________ ____________________________

WITNESS TO SIGNATURE OF

____________________________ ____________________________

WITNESS TO SIGNATURE OF